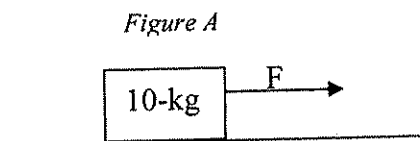


AP Physics - Mechanics

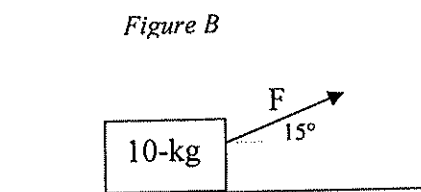
handout 6-0

1. If friction is neglected for figure A, determine:
 - a) the value of F needed to cause an acceleration of 2.0 m/s^2 to the right.
 - b) the work done by the force F as it moves 5.0-m to the right.
 - c) the work done by gravity as it moves 5.0-m to the right.
 - d) the work done by the normal force as it moves 5.0-m to the right.
 - e) the net work done on the box.



2. If the coefficient of friction for figure A is 0.22 , determine:
 - a) the value of F needed to cause an acceleration of 2.0 m/s^2 to the right.
 - b) the work done by the force F as it moves 5.0-m to the right.
 - c) the work done by gravity as it moves 5.0-m to the right.
 - d) the work done by the normal force as it moves 5.0-m to the right.
 - e) what type of friction is being considered and the work done by friction as it moves 5.0-m to the right.
 - f) the net work done on the box.

3. If the coefficient of friction for figure B is 0.22 , determine:
 - a) the value of F needed to cause an acceleration of 2.0 m/s^2 to the right.
 - b) the work done by the force F as it moves 5.0-m to the right.
 - c) the work done by gravity as it moves 5.0-m to the right.
 - d) the work done by the normal force as it moves 5.0-m to the right.
 - e) what type of friction is being considered and the work done by friction as it moves 5.0-m to the right.
 - f) the net work done on the box.



4. If the coefficient of friction for figure C is 0.22 , determine:
 - a) the net work done on the box? The box moves 2.0m
 - b) the work done by gravity as it moves 2.0-m downhill.
 - c) the work done by the normal force as it moves 2.0-m downhill.
 - d) what type of friction is being considered and the work done by friction as it moves 2.0-m downhill.

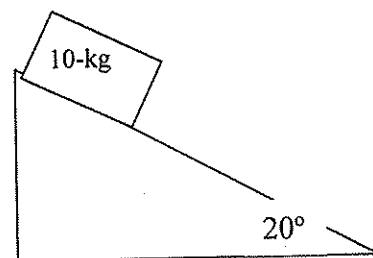


Figure C

5. A crane lifts a (1100-kg) car vertically at a constant speed. If the car is raised a total height of 4.0-m determine:
 - a) the value of the force needed to lift the car.
 - b) the work done by this lifting force.
 - c) the work done by gravity.
 - d) the net work done on the car.
6. A crane lifts a (1100-kg) car vertically with an acceleration of 0.75 m/s^2 . If the car is raised a total height of 4.0-m during this acceleration determine:
 - a) the value of the force needed to lift the car.
 - b) the work done by this lifting force.
 - c) the work done by gravity.
 - d) the net work done on the car.
7. An electron has a mass of $9.11 \times 10^{-31} \text{ kg}$. A certain elephant weighs 6600-Lbs . If this elephant walked with a speed of 2.1 m/s would it be possible for the electron to have the same kinetic energy? Support your answer.
 HINT: the speed of light is $6.706 \times 10^8 \text{ mph}$ and there are $1609 \text{ meters in a mile}$.

CONTINUE →

8. What is the airspeed of an unladen swallow? What do you mean; an African or European Swallow?

If the average mass of a European Swallow is 20.3-grams and that of the African Swallow is 141.75-grams determine the speed of each when they have the same kinetic energy (1.228Joules).

9. Which has more potential energy: a 10-pound bowling ball that is 1.0 meter above the ground or a 2.7-gram ping pong ball that is 1000-m above the ground?

kip 10. How much energy is stored in a pinball machine spring (constant = 750 N/m) that is compressed 3.0-cm?

11. Mrs Klein (59-kg) climbs a ladder to the top of the roof (3.8-m) in 18-seconds. Mr. Bruening (115-kg) completes the same task in 22-seconds and Mrs. Austin (55.5-kg) can do it in 15-seconds. Rank the teachers in order of the most powerful to the least.

12. A corvette can go from 0 – 60 mph in 4.3 seconds. If the mass of the car is 1443-kg how much work is required to complete this task (assuming it is on a horizontal road)? B) What is the power (in HP) of the corvette?

13. How much work is required to lift a 10-kg object above your head (approximately 1.3-m)?

14. An 1100-kg car accelerates from rest to 90-km/h over a distance of 25.0-m. How much work is done? B) What is the average force applied through this distance?

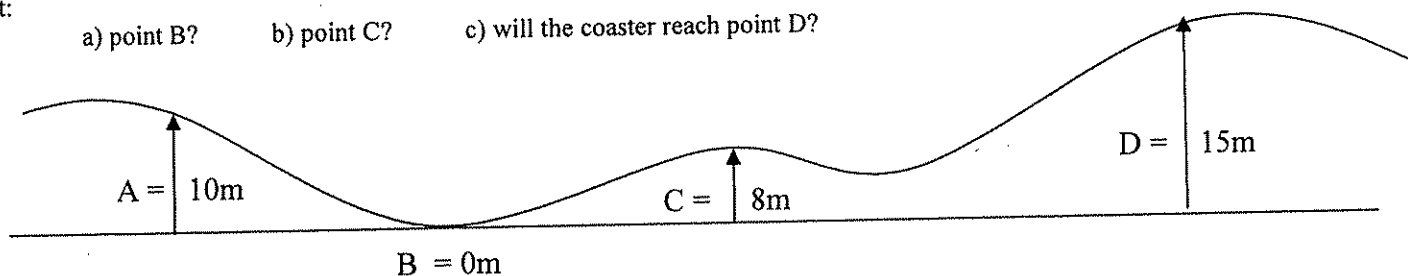
15. A fighter jet (mass = 6020kg) is launched from an aircraft carrier with the aid of its own engines and a catapult. The thrust of the engines is 23000N. In being launched from rest is moved through a distance of 87-m and has a kinetic energy of 4.5×10^7 J at lift off.
a) what is the acceleration of the jet? B) what is the work done by the engines? C) what is the work done by the catapult?

16. A 5.0-kg box experiences an applied force of $(15\hat{i} - 9\hat{j})$ N, as it slides across a horizontal surface 3.0-m. Determine:
a) the acceleration of the box. b) the work done by the applied force.

17. For the situation described above, the box also experiences a frictional force as it is moving. The coefficient of kinetic friction between the box and surface is 0.22. Determine:
a) the acceleration of the box. b) the work done by the applied force. c) the work done by friction d) the net work.

18. A rollercoaster is designed (without friction) as shown in the diagram below. If the speed at point A is 5.0 m/s, what is the speed at:

a) point B? b) point C? c) will the coaster reach point D?



19. If the speed of the rollercoaster (shown above) is 10.5m/s at point B, determine the work done by friction (from A to B).
b) if the average angle of incline between points A and B is 40° and the mass of the car is 900-kg, determine the force of friction.
c) Determine the coefficient of friction.

20) A slow moving car may have more kinetic energy than a fast moving car. How is this possible?

21) Determine if each of the following quantities can be positive or negative:
a) work b) power c) potential energy d) kinetic energy

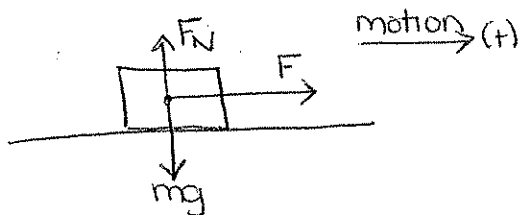
22) Suppose (neglecting friction) that the kinetic energy of a system decreases. What happens to the potential energy? Give an example of this occurring.

23) A person is riding a Ferris Wheel. In one complete rotation of the wheel is the net work done by gravity positive, negative or zero? WHY?

24) A mountain climber has the option of taking two paths up a very large mountain. Path A winds up the side of the mountain while path B is almost a vertical ascent. If both paths lead the same location which path would require more work done by the climber?

WORK + ENERGY PRACTICE - HANDOUT 1

①



$m = 10 \text{ kg}$
 $a = 2 \text{ m/s}^2$
 $d = 5.0 \text{ m}$

a) $F_{\text{net}} = ma$
 $F = (10)(2)$
 $F = 20 \text{ N}$

b) $W_F = F_{\parallel} d$
 • Is F parallel to d ?
 YES
 • Is F in the same direction as d ?
 YES (So W is +)

$W_F = (20 \text{ N})(5 \text{ m})$
 $W_F = 100 \text{ J}$

c) $W_g = F_{g\parallel} d$
 • Is F_g parallel to d ?
 No - gravity is down while d is horizontal

$W_g = 0 \text{ J}$

d) $W_N = F_{N\parallel} d$
 • Is F_N parallel to d ?
 No - F_N is up while d is horizontal

$W_N = 0 \text{ J}$

e) $W_{\text{net}} = F_{\text{net}} d$
 • F_{net} is parallel to d AND in the same direction.

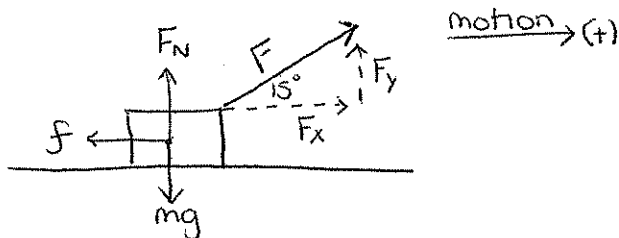
$F_{\text{net}} = ma = 20 \text{ N}$

$W_{\text{net}} = F_{\text{net}} d$

$W_{\text{net}} = 100 \text{ J}$

② ON THE BACK

③



$\mu = 0.22$
 $a = 2.0 \text{ m/s}^2$
 $m = 10 \text{ kg}$
 $d = 5 \text{ m}$

a) $F_{\text{net}} = ma$
 $F_x - f = ma$
 $F \cos 15^\circ - \mu(mg - F \sin 15^\circ) = ma$
 $F(\cos 15^\circ + \mu \sin 15^\circ) = ma + \mu mg$

$F = 40.63 \text{ N}$

b) $W_F = F_{\parallel} d$
 ↳ you can only use the parallel component!

$W_F = (F \cos 15^\circ) d$

$W_F = 196.23 \text{ J}$

c) $W_g = F_{g\parallel} d$
 Not parallel

$W_g = 0$

d) $W_N = F_{N\parallel} d$
 Not parallel

$W_N = 0$

e) Kinetic

$W_f = -f_{\parallel} d$

$W_f = (-\mu F_N) d$

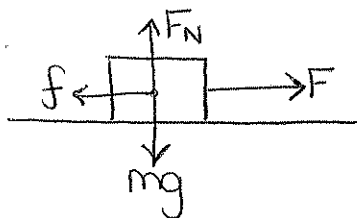
$W_f = -\mu(mg - F \sin 15^\circ) d$

$W_f = -96.23 \text{ J}$

f) $W_{\text{net}} = F_{\text{net}} d$
 where $F_{\text{net}} = ma$
 $F_{\text{net}} = 20 \text{ N}$

$W_{\text{net}} = (20 \text{ N})(5 \text{ m}) = 100 \text{ J} = W_{\text{net}}$

②



$$m = 10 \text{ kg} \quad d = 5 \text{ m}$$

$$a = 2 \text{ m/s}^2 \quad \mu = 0.22$$

a) $F_{\text{net}} = ma$

$F - f = ma$

$F = ma + f$

$F = ma + \mu mg$

$F = 41.56 \text{ N}$

b) $W_F = F_{\parallel} d$

$W_F = (41.56 \text{ N})(5 \text{ m})$

$W_F = 207.8 \text{ J}$

c) $W_g = F_{g\parallel} d$

$W_g = 0 \text{ J}$

b/c they are NOT parallel

d) $W_N = F_{N\parallel} d$

$W_N = 0 \text{ J}$

b/c they are NOT parallel

e) $W_f = -f d$

$W_f = -(\mu F_N) d$

$W_f = -\mu(mg) d$

$W_f = -107.8 \text{ J}$

f) $W_{\text{net}} = F_{\text{net}} d$

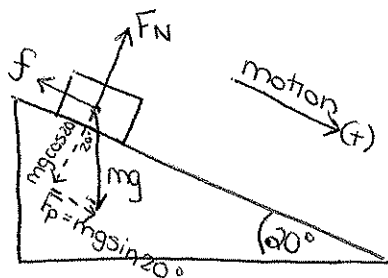
where $F_{\text{net}} = ma = 20 \text{ N}$

$W_{\text{net}} = (20 \text{ N})(5 \text{ m})$

$W_{\text{net}} = 100 \text{ J}$

③ IS ON THE FRONT.

④



$m = 10 \text{ kg}$

$\mu = 0.22$

$d = 2.0 \text{ m}$

a) $W_{\text{net}} = F_{\text{net}} d$

where $F_{\text{net}} = ma$ (don't accel.)

$F_{\text{net}} = F_p - f$

$F_{\text{net}} = mg \sin 20^\circ - \mu F_N$

$F_{\text{net}} = mg \sin 20^\circ - \mu mg \cos 20^\circ$

$F_{\text{net}} = 13.26 \text{ N}$

$W_{\text{net}} = 26.52 \text{ J}$

b) $W_F = ?$

There is No applied force
SKIP IT!

c) $W_g = F_{g\parallel} d$

the component of mg parallel to d is $F_p = mg \sin \theta$

$W_g = (mg \sin 20^\circ) d$

$W_g = 67.04 \text{ J}$

d) $W_N = F_{N\parallel} d$

0 J b/c

these are NOT parallel!

e) Kinetic

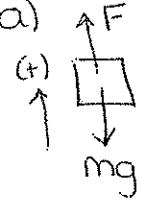
$W_f = -f_{\parallel} d$

$W_f = -(\mu F_N) d$

$W_f = -\mu(mg \cos 20^\circ) d$

$W_f = -40.52 \text{ J}$

5) $m = 1100 \text{ kg}$
 $a = 0 \text{ m/s}^2$
 $d = h = 4.0 \text{ m}$

a)  $F_{\text{net}} = ma$
 $F - mg = ma$
 $F = mg$
 $F = 10780 \text{ N}$

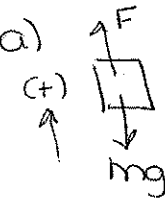
b) $W_F = F_{\text{net}} d$
 $W_F = (10780 \text{ N}) h$
 $W_F = 43120 \text{ J}$

c) $W_g = F_{g \parallel} d$
 $W_g = -(mg) h$

d) $W_{\text{net}} = F_{\text{net}} d$
 $W_{\text{net}} = 0 \text{ J}$

$W_g = -43120 \text{ J}$

6) $m = 1100 \text{ kg}$
 $a = 0.75 \text{ m/s}^2$
 $d = h = 4 \text{ m}$

a)  $F_{\text{net}} = ma$
 $F - mg = ma$
 $F = ma + mg$
 $F = 11605 \text{ N}$

b) $W_F = F_{\text{net}} d$
 $W_F = (11605 \text{ N})(4 \text{ m})$
 $W_F = 46420 \text{ J}$

c) $W_g = F_{g \parallel} d$
 $W_g = -(mg) h$

$W_g = -43120 \text{ J}$

d) $W_{\text{net}} = F_{\text{net}} d$ $F_{\text{net}} = ma$
 $W_{\text{net}} = (ma) d$
 $W_{\text{net}} = 3300 \text{ J}$

electron

7) $m = 9.11 \times 10^{-31} \text{ kg}$

$v_e = ?$

$KE = 6615 \text{ J}$

$KE = \frac{1}{2} m v^2$

$v = \sqrt{\frac{2KE}{m}}$

Elephant

$m = 2000 \text{ kg}$

$v_e = 2.01 \text{ m/s}$

$KE = \frac{1}{2} m v^2$

$KE = 6615 \text{ J}$

$v = 1.205 \times 10^{17} \text{ m/s}$ NOT possible b/c it is faster than the speed of light

⑧ $KE = 1.228 J$

African

$m_A = 141.75 g = 0.14175 kg$

$V_A = ?$

$KE = \frac{1}{2}mv^2$

$V_A = \sqrt{\frac{2KE}{m}}$

$V_A = 4.16 m/s$

European

$m_E = 20.3 g = 0.0203 kg$

$V_E = ?$

$V_E = \sqrt{\frac{2KE}{m}}$

$V_E = 11.0 m/s$

⑨ Bowling Ball

$m = 4.55 kg$

$h = 1.0 m$

$PE_B = mgh$

$PE = 44.59 J$

Ping Pong

$m = 0.0027 kg$

$h = 1000 m$

$PE_P = mgh$

$PE = 26.46 J$

★ The bowling ball has more PE

⑩ $PE = \frac{1}{2}kx^2$

$PE = \frac{1}{2}(750)(0.03)^2 = 0.34 J = PE$

⑪ Klein

$W = \Delta PE = mgh$

$W_K = 2197.16 J$

Brueening

$W = mgh$

$W_B = 4282.6 J$

Austin

$W_A = mgh$

$W_A = 2066.82 J$

$P_K = \frac{W_K}{t} = 122.06 \text{ Watts}$

III

$P_B = \frac{W_B}{t} = 194.66 \text{ Watts}$

I

$P_A = \frac{W_A}{t} = 137.79 \text{ Watts}$

II

12) $V_0 = 0$

$V_f = 60 \text{ mph}$

$V_f = 26.82 \frac{m}{s}$

~~W = 518984 J~~

~~W = 518984 J~~

$W = \Delta KE$

$W = \frac{1}{2}m(V_f^2 - V_0^2)$

$W = 518984 J$

$W = 519 kJ$

b) $P = W/t$

$P = 120694 \text{ Watts}$

$P = 158 \text{ HP}$

⑬ $W = mg\Delta h$

$W = 127.4 \text{ J}$

⑭ $m = 1100 \text{ kg}$

$V_0 = 0$

$V_f = 90 \frac{\text{km}}{\text{h}} = 25 \frac{\text{m}}{\text{s}}$

$d = 25 \text{ m}$

a) $W = \Delta KE$

$W = \frac{1}{2}m(V_f^2 - V_0^2)$

$W = 343,750 \text{ J}$

b) $W = Fd$

$F = \frac{W}{d} = 13750 \text{ N}$

⑮ $F_T = 23,000 \text{ N}$

$F_c = ?$

$d = 87 \text{ m}$

$KE = 4.5 \times 10^7 \text{ J}$

$V_0 = 0$

$mg = 5.9 \times 10^4 \text{ N}$

$m = 6020 \text{ kg}$

b/c $KE_f = \frac{1}{2}mV_f^2$

$V_f = \sqrt{\frac{2KE}{m}}$

$V_f = 122.3 \text{ m/s}$

$\hookrightarrow V_f^2 = V_0^2 + 2ad$

$a = \frac{V_f^2 - V_0^2}{2d}$

$a = 85.96 \text{ m/s}^2$

b) $W_T = F_T d = 2,001,000 \text{ J}$

$F_{\text{net}} = ma$

$F_T + F_c = ma$

$F_c = ma - F_T$

$F_c = 49,447.9 \text{ N}$

c) $W_c = F_c d$

$W_c = 43,019,673 \text{ J}$

$W_c = 43 \text{ MJ}$ WOW!

there are a few other ways to do this.

$$19) mgh_A + \frac{1}{2}mv_A^2 = \frac{1}{2}mv_B^2 + mgh_B + W_{NC}$$

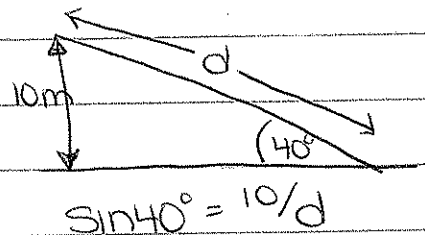
$$mgh_A + \frac{1}{2}m(v_A^2 - v_B^2) = W_{NC}$$

$$W_{NC} =$$

$$b) W_{NC} = W_f = fd$$

$$W_{NC} = f \left(\frac{10}{\sin 40^\circ} \right)$$

$$f = \frac{W_{NC} \sin 40^\circ}{10} =$$



$$c) f = \mu F_N = \mu mg \cos \theta \quad \mu = \frac{f}{mg \cos \theta} =$$

20) Because Kinetic energy is a relationship ~~concern~~ concerning mass and velocity. The slow moving car ~~could~~ would have a ~~small~~ energy.

21) Work $\rightarrow$ Pos or Neg Potential Energy $\rightarrow$ Pos or Neg
Power $\rightarrow$ Pos or Neg Kinetic Energy $\rightarrow$ Pos.

22) As KE decreases the PE increases (for a conservative system).

Example - ~~the~~ Throw an object upward.

23) ZERO! The total displacement is zero!

24) If he is only working against gravity then the work done is the same.