3.2.4 In Class or Homework Exercise

1. A 7.0 kg monkey swings from a branch to another 1.6 m higher. What is the change in potential energy?
   We will use his starting point as the reference level,

   $m = 7.0kg$
   $h_f = 1.6m$
   $h_i = 0$
   $\Delta E_p = ?$

   $\Delta E_p = E_{pf} - E_{pi}$
   $= mgh_f - mgh_i$
   $= mg(h_f - h_i)$
   $= (7.0)(9.80)(1.6 - 0)$
   $= \boxed{110J}$

2. A student lifts her books from the floor into her locker, which is 1.4 m above the floor. If she did 39 J of work, what is the mass of the books?
   Using the floor as the reference level,

   $W = 39J$
   $h_f = 1.6m$
   $h_i = 0$
   $m = ?$

   $W = \Delta E_p$
   $W = mgh_f - mgh_i$
   $39 = m(9.80)(1.4) - 0$
   $m = \boxed{2.8kg}$

3. A 55 kg hiker starts at an elevation of 1300 m and climbs to the top of a 3100 m peak.
   a. What is the hiker's change in potential energy?

   $m = 55kg$
   $h_i = 1300m$
   $h_f = 3100m$
   $\Delta E_p = ?$

   $\Delta E_p = E_{pf} - E_{pi}$
   $= mgh_f - mgh_i$
   $= mg(h_f - h_i)$
   $= (55)(9.80)(3100 - 1300)$
   $= \boxed{9.7 \times 10^5 J}$

   b. What is the minimum work required of the hiker?
   Since $W = \Delta E_p$, the minimum work required is also $\boxed{9.7 \times 10^5 J}$

   c. Can the actual work done be more than this? Explain.

Yes, the actual work done can be more than this since the hiker may have gained kinetic energy by speeding up or lost some energy to heat.

4. A motor is being used to lift a 225 kg load. It must lift the load to a height of 10.0 m and attain a speed of 4.0 m/s by the time that it reaches this height.
   a. How much work does the motor have to do?

   The motor is giving the load both potential and kinetic energy. We must first find each of these.

   $m = 225kg$

   $\Delta h = 10.0m$

   $v_i = 0$

   $v_f = 4.0m/s$

   $W_{ext} = ?$

   $$\begin{aligned}\Delta E_p &= mgh_f - mgh_i \\ &= mg\Delta h \\ &= (225)(9.80)(10.0) \\ &= 22100J\end{aligned}$$

   $$\begin{aligned}\Delta E_k &= \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2 \\ &= \tfrac{1}{2}(225)(4.0)^2 - 0 \\ &= 1800J\end{aligned}$$

   $$\begin{aligned}W_{ext} &= \Delta E_k + \Delta E_p \\ &= 1800 + 22100 \\ &= \boxed{23900J}\end{aligned}$$

   b. What power output must it have?

   Since we know the work done by the motor, we now need the time required:

   $v_i = 0$

   $v_f = 4.0$

   $\Delta d = 10.0m$

   $t = ?$

   $$\Delta \vec{d} = \frac{\vec{v}_i + \vec{v}_f}{2}t$$

   $$10.0 = \frac{0 + 4.0}{2}t$$

   $$t = 5.0s$$

   We can now calculate the power needed:

   $$\begin{aligned}P &= \frac{W}{t} \\ &= \frac{23900}{5.0} \\ &= \boxed{4800W}\end{aligned}$$

5. An amount of work W was done on one ball to raise it to a height h. How much work must you do on four balls, all identical to the first, to raise them to twice the height h?
   Since raising one ball to twice the height takes twice as much work ($W = mg\Delta h$), and we are lifting 4 balls, it would take 8 times as much work (8W).

6. A book is sitting on a shelf above a desk. Explain what is wrong with the statement, “The gravitational potential energy of the book is 15 J.”
   When stating the gravitational potential energy of an object, it is necessary to state the reference level where the gravitational potential energy is considered to be zero.