Energy Unit: Review Solutions

Answer the questions to the best of your ability in the spaces provided on the question sheets. If you run out of room for an answer, continue on the back of the page.

Name and section: _____

Date: _____

1. If the statement is false, change the statement to make it true.

   (a) **True** **False** Units of work would be equivalent to a Newton times a meter.
   True

   (b) **True** **False** A force is applied by a chain to a roller coaster car to carry it up the hill of the first drop of the Shockwave ride. This is an example of work being done.
   True

   (c) **True** **False** Power refers to how fast work is done upon an object.
   True

   (d) **True** **False** If an object is on the ground, then it does not have any ~~kinetic~~ **potential** energy **if the ground is considered zero potential energy**.
   False

   (e) **True** **False** Potential energy is a scalar quantity.
   True

   (f) **True** **False** Gravitational potential energy is lost as objects free-fall to the ground.
   True

   (g) **True** **False** If the ~~speed~~ **mass** of an object is doubled, its kinetic energy will also be doubled
   False

   (h) **True** **False** Object A has a mass of 1 kg and a speed of 2 m/s. Object B has a mass of 2 kg and a speed of 1 m/s. Object~~s~~ A ~~and B have the same~~ **will have twice the** kinetic energy **of Object B**.
   False

   (i) **True** **False** A 60-kg boy runs up a 2.0 meter staircase in 1.5 seconds. His power is approximately ~~80~~ **780** Watt.
   False

   (j) **True** **False** A 300-Newton force is applied to a skier to drag her up a ski hill at a constant speed of 1.5 m/s. The power delivered by the toe rope is 450 Watts.
   True

Short Answer

2. For each example, state either what type of heat transfer (convection, conduction or radiation) or what type of simple machine (lever, pulley, inclined plane, screw, wheel and axle or wedge) it is

   (a) Screwdriver (machine)

   (a) **wheel and axle**

   (b) Campfire (heat transfer)

   (b) **radiation**

   (c) Teeter-totter (machine)

   (c) **lever**

   (d) Ramp (machine)

   (d) **inclined plane**

   (e) Pot on a hot element (heat transfer)

   (e) **conduction**

   (f) scissors (machine)

   (f) **lever**

Problems

Remember to box your final answer in each question. Show all of your work for full marks: name/list variables (this means for each question you must name all variables), draw a picture (if it helps), write your starting equation etc (full marks will be deducted for not following these instructions). Half marks will be deducted for incorrect significant figures or units. No marks will be given for answers only.

3. What is the potential energy of a 2.5 kg ball held 17 m off the ground, if the ground is considered to be zero potential energy?

Solution: m =2.5 kg, h =173

$$\begin{aligned} E_p &= mgh \\ &= (2.5\text{kg})(9.81\text{m/s}^2)(17\text{m}) \\ &= 420\text{J} \end{aligned}$$

4. (a) How much work is done by a 150 kg pig running from rest to 5 m/s in 20 seconds over a flat field?

Solution: $m = 150$ kg, v_f =5m/s, t =20s, v_i=0

$$\begin{aligned} W &= \Delta E_k \\ &= \frac{1}{2}mv_f - \cancel{\frac{1}{2}mv_i} \\ &= \frac{1}{2}(150\text{kg})(5\text{m/s}) \\ &= 1875\text{J} \\ &\approx 2000\text{J} \end{aligned}$$

(b) What is the power output of the pig?

Solution:

$$\begin{aligned} P &= \frac{W}{\Delta t} \\ &= \frac{1875\text{J}}{20\text{s}} \\ &\approx 90\text{W} \end{aligned}$$

5. What is the kinetic energy of a 1.5 kg ball traveling at 5 m/s?

Solution: m =1.5 kg, v =5m/s

$$\begin{aligned} E_k &= \frac{1}{2}mv^2 \\ &= \frac{1}{2}(1.5\text{kg})(5\text{m/s})^2 \\ &= 20\text{J} \end{aligned}$$

6. A 12 kg block is being push with a force of 12 N up plane inclined 25° with coefficient of friction $\mu = 0.21$ How much work is being done on the block when it is moved 5 m up the plane?

Solution: $F = 12\text{N}$, $d = 5\text{m}$

$$\begin{aligned} W &= \mathbf{F} \cdot \mathbf{d} \\ &= (12\text{N})(5\text{m}) \\ &= 60\text{J} \end{aligned}$$

7. A cyclist starts from rest at the top of a 24 m hill as measured from the bottom of the hill. She rides down the hill and continues up a 12 m hill, measured from the same reference as the first hill.

   (a) What is the speed of the cyclist between the hills?

Solution: $h_i = 24\text{m}$, h_f =0

$$\begin{aligned} \cancel{E_{k,i}} + E_{p,i} &= E_{k,f} + \cancel{E_{p,f}} \\ \cancel{m}gh_i &= \frac{1}{2}\cancel{m}v^2 \\ v &= \sqrt{2gh} \\ &= \sqrt{2(9.81\text{m/s}^2)(24\text{m})} \\ &= 22\text{m/s} \end{aligned}$$

(b) What is the speed of the cyclist at the top of the second hill?

Solution: h_i=0, h_f =12m, v_i=22m/s, v_f =?

$$\begin{aligned}
E_{k,i} + \cancel{E_{p,i}} &= E_{k,f} + E_{p,f} \\
\frac{1}{2}\cancel{m}v_i^2 &= \frac{1}{2}\cancel{m}v^2 + \cancel{m}gh \\
v_i^2 &= v^2 + 2gh \\
v &= \sqrt{v_i^2 - 2gh} \\
&= \sqrt{(22\text{m/s})^2 - 2(9.81\text{m/s}^2)(12\text{m})} \\
&= 15\text{m/s}
\end{aligned}$$

8. A 250 mL cup of water (C=4186 J/(kg K), density is 1 kg/L) is heated from 293 K to 373 K. How much heat is transfered to the water?

Solution: V = 250mL=.25L, m = 0.25 kg, T_i=293 K, T_f=373 K. C =4186 J/(kg K)

$$\begin{aligned}
Q &= mc\Delta T \\
&= (0.25\text{kg})[4186\text{J/(kg K)}](373\text{K} - 293\text{K}) \\
&= 84000\text{J}
\end{aligned}$$

9. Assume we have an inclined plane with an efficiency rating of 35%. If we wanted to lift a 45 kg boy 1.5 m (I'm not sure why we want to move the boy, but there is a very good reason), how much input work would be needed?

Solution: E_{ff}=35%=0.35, m = 45kg, Δh =1.5m, W_{in} =?

$$\begin{aligned}
E_{ff} &= \frac{W_{out}}{W_{in}} \\
W_{in} &= \frac{W_{out}}{E_{ff}} \\
&= \frac{mg\Delta h}{E_f f} \\
&= \frac{(45\text{kg})(9.81\text{m/s}^2)(1.5\text{m})}{0.35} \\
&= 1900\text{J}
\end{aligned}$$