TUTORIAL QUESTIONS WORK ENERGY POWER 2

Question 1

a.) **$5 \cos 37° \times 10 = 40$ J**

b) **None, since the force of gravity acts perpendicular to the direction of the path. There is no component of the gravitational force in the direction of the motion.**

Question 2

Total work done = gain in K.E.

$(3 - 1)(5) = \frac{1}{2} mv^2$

$v = 44.7$ ms^{-1}

Question 3

Loss in P.E. = Gain in K.E

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

$v = \sqrt{(2gh)} = 14$ ms^{-1}

Loss in P.E. = Gain in K.E. + Work done against friction

$(30)(9.81)(10) = \frac{1}{2} (30)(8)^2$ + Work done against friction

Work done against friction = 1980 J

Question 4

In order for the ball not to hit the professor, the final gain in P.E. must be the same as initial P.E. For that to happen, the initial K.E. that was supplied must all be used to do work against air friction.

Work was done against air friction = $\frac{1}{2} (3)(1)^2$ = **1.5 J**

Question 5

a.) $mgh = (80)(9.81)(12\,000 \sin 10°)$ = **1.63×10^6 J**

b.) work done against gravity = mgh = **1.63×10^6 J**

c.) Power = mgh / time = $1.63 \times 10^6 / 3600$ **= 453 W**

Question 6

Object	K.E. = ½mv^2, (J)	Stopping distance = K.E. / 2, (m)	Stopping time = (mv – mu) / F, (s)
Big sphere	5	2.5	5
Small sphere	18	9	3

Shortest distance = big sphere
Shortest time = small sphere

Question 7

Since there are no external forces during the collision, the total momentum is the same before as after the collision:
$m_{Tarzan}\, v_{initial} = (m_{Tarzan} + m_{Jane})v_f$ --- (1)

For Tarzan's initial swing down to Jane:
Loss in P.E. = Gain in K.E.
$mg(h – h\cos 53°) = ½mv_{Tarzan}^2$
$v_{Tarzan} = \sqrt{(0.8gh)}$ --- (2)

For Tarzan's swing up with Jane:
Loss in K.E. = Gain in P.E.
$½(m_{Tarzan} + m_{Jane})\, v_f^2 = (m_{Tarzan} + m_{Jane})g(h – h\cos 37°)$
$V_f = \sqrt{(0.4gh)}$ --- (3)

Substituting (3) & (2) into (1):
$(m_{Tarzan}) \sqrt{(0.8gh)} = (m_{Tarzan} + m_{Jane})\sqrt{(0.4gh)}$
$(m_{Tarzan}) \sqrt{(2)} = (m_{Tarzan} + m_{Jane})$
$(m_{Tarzan}) = 50 / (\sqrt{2} -1) = 121$ kg

Question 8

$P_{initial} = P_{after}$
$mu = m(-v) + 4m(v)$
$v = u / 3$

The velocity of block m is negative because it is moving in the opposite direction as the 4m block. Since there is no friction, loss in K.E. is equals gain in P.E. and vice versa.
Thus, we have $mgh = ½mv^2$ or $h = v^2/2g$ and
$mgh_0 = ½mu^2$ or $h_0 = u^2/2g$

$h / h_0 = (v^2/2g)/(u^2/2g) = v^2 / u^2 = (u/3)^2 / u^2 = 1/9$
$h = h_0 / 9$

Question 9

This problem is best solved in two steps. First the collision between the bullet and the block. The second part is the swinging up of the block and the bullet. Since there are no external forces during the collision, momentum is conserved when the bullet collides with the block:

$P_{initial} = P_{after}$
$mv_0 = (M + m)\ v$
$v = mv_0 / (M + m)$ --- (1)

where v is the speed of the block (plus bullet) just after the collision. Then
Loss in K.E. when object starts to move together = gain in P.E.
$\frac{1}{2}(M + m)v^2 = (M + m)gh$
$v = \sqrt{(2gh)}$ --- (2)

Substitute (2) to (1):
$\sqrt{(2gh)} = mv_0 / (M + m)$
$\mathbf{v_0 = \sqrt{(2gh)}\ (M + m) / m}$

Question 10

$\text{Efficiency} = P_{out} / P_{in}$
$20\% = [(2 \times 0.8) / 4] / P_{in}$
$\mathbf{P_{in} = 2\ W}$

Question 11

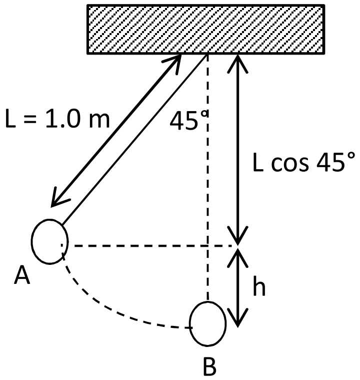
a.) $K.E._i + P.E._i = K.E._f + P.E._f$
$\frac{1}{2}(m)(10)^2 + m(9.81)(5) = \frac{1}{2}(m)(v)^2 + 0$
$\mathbf{v = 14.1\ ms^{-1}}$

b.) $K.E._i + P.E._i = K.E._f + P.E._f$
$\frac{1}{2}(m)(10)^2 + (m)(9.81)(5) = \frac{1}{2}(m)(v)^2 + (m)(9.81)(3)$
$\mathbf{v = 11.8\ ms^{-1}}$

Question 12

$K.E._i + P.E._i + W_{done\ against\ air} = K.E._f + P.E._f$
$\frac{1}{2}(1.6)(25)^2 + 0 + W_{done\ against\ air} = 0 + (1.6 \times 9.81 \times 20)$
$\mathbf{W_{done\ against\ air} = 186.1\ J}$ **(energy loss)**

Question 13



Gain in K.E. = ½ (0.10)(2.2)^2 =0.242 J

Loss in P.E. = mgh = (0.10)(9.81)(1.0 – 1.0 cos 45°) =0.287 J

Loss in energy due to air resistance = 0.287 - 0.242

= 0.045 J

Question 14

a.) Average power, P = work done / time

work done = area under graph = ½ (5)(2) = 5 J

P = 5 / 1.5 = 3.3 W

b.) Average power, P = work done / time

work done = area under graph = (5)(2) = 10 J

P = 10 / 2 = 5 W

c.) Average power, P = work done / time

work done = area under graph = ½(5)(2) + (5)(2) = 15 J

P = 15 / 3.5 = 4.3 W **[**It is not (5 + 3.3) = 8.3 W!!]**

Question 15

a.) P = $F_{applied}v$

$F_{applied}$ = 3 500 / 20 = 175 N

Since car is moving at constant speed, thus total resistance = force applied = 175 N

b.) P = $F_{applied}v$

$F_{applied}$ = component of weight parallel to incline + total resistance

$F_{applied}$ = mg sin30° + 175

P = (mg sin30° + 175)(20)

P = (950 x 9.81 sin30° + 175)(20) = 96 700 W

Question 16

$P = F_{applied}v$

$F_{applied} – 500 = ma$
$F_{applied} = (ma + 500)$

$v = u + at \rightarrow v = at$, since u is zero.

$P = (ma + 500)(at)$
$P = [(900 \times 1.5) + 500] \times (1.5 \times 5.0) = 13\ 875$ W