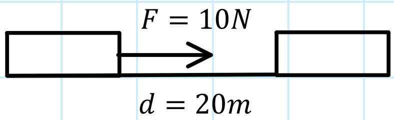
P11 - 6.1 - Work $W = Fd$ Notes

What is the work done on an Object with a Force of 10 N over a distance of 20 m.

$w = ? = 200J$



$W = F_{||}d$
$W = 10 \times 20$
$W = 200\ Nm$

$W = F_{||}\,d$

$Work = Force \times Distance$

$1J = 1Nm$

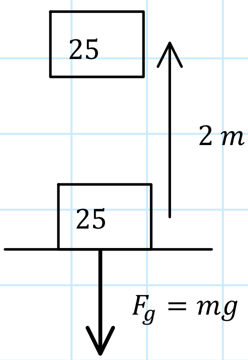
$Joules\ (J)$

How much energy was exerted?

$W = \Delta E$
$\Delta E = W$
$\Delta E = 200J$

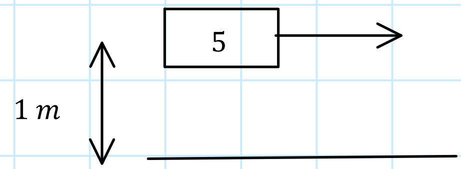
$W = \Delta E$

Find the work done lifting an Object with a Mass of 25 kg straight up a distance of 2 m.



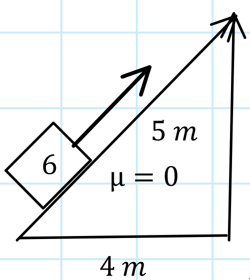
$W = F_{||}\,d$
$W = mgd$
$W = 25(9.8)(2)$
$W = 490\ J$

How much work is done on a book with $m = 5\ kg$ carried at a constant $h = 1\ m$.



$0\ J$

A 6 kg Case is carried up a 5 m ramp over a length of 4 m. Find the Work done on the Case. $\mu = 0$!

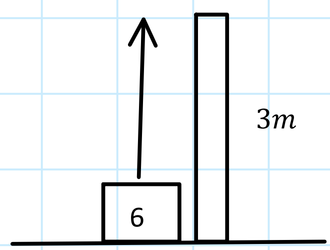


3 m

$b = \sqrt{c^2 - a^2}$
$b = \sqrt{5^2 - 4^2}$
$b = 3$

$W = F_{||}d$
$W = mgd$
$W = 6(9.8)(3)$
$W = 176.4\ J$

A 6 kg Case is carried staight up 3 m. What is the Work done on the Case?

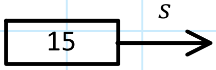


$W = 176.4\ J$

P11 - 6.2 - Kinetic Potential Conservation Energy Notes

Kinetic Energy, E_k*: Energy due to an objects Motion.*

$v = 25\frac{m}{s}$



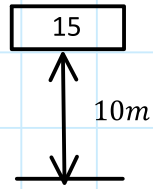
$E_k = \frac{1}{2}mv^2$

$E_k = \frac{1}{2}(15)(25)^2$

$E_k = 4687.5\,J$

$\boxed{E_k = \frac{1}{2}mv^2}$

Potential Energy, E_p*: Energy due to an objects Height (Stored Energy)*



$\boxed{E_p = mgh}$

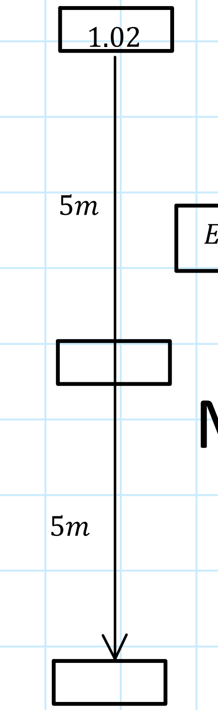
$E_p = mgh$

$E_p = 15 \times 9.8 \times 10$

$E_p = 1470\,J$

> *Law of Conservation of Energy : cannot be created or destroyed, must be conserved!*

Ball Drop



	Total	Kinetic	Potential
Top	$E_t = 100\,J$	$E_k = 0\,J$, at rest	$E_p = mgh$ $E_p = (1.02)(9.8)(10)$ $E_p = 100\,J$ $E_k = 0\,J$
Middle	$E_t = 100\,J$	$E_k = \frac{1}{2}mv^2$ $v = \sqrt{\frac{2E_k}{m}}$ $v = \sqrt{\frac{2(50)}{1.02}}$ $v = 9.9\frac{m}{s}$	$E_p = mgh$ $E_p = (1.02)(9.8)(5)$ $E_p = 50\,J$ $E_k = 50\,J$
Bottom*	$E_t = 100\,J$	$E_k = \frac{1}{2}mv^2$ $v = \sqrt{\frac{2E_k}{m}}$ $v = \sqrt{\frac{2(100)}{1.02}}$ $v = 14\frac{m}{s}$	$E_p = mgh$ $E_p = (1.02)(9.8)(0.001)$ $E_p = 0.01\,J$ $E_k = 100\,J$

$\boxed{E_t = E_k + E_p}$

"a" Energy – Kinematics Link

$v_f^2 = v_i^2 + 2ad$

$v_f = \sqrt{2ad}$

$v_f = \sqrt{(2)(-9.8)(-10)}$

$v_f = 14\frac{m}{s}$

Total Initial Energy = Total Final Energy

$$E_i = E_f$$

$$E_{ki} + E_{pi} = E_{kf} + E_{pf}$$

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

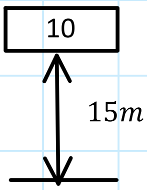
$$\Delta E_p + \Delta E_k = 0$$

$$\Delta E_p = -\Delta E_k$$

Total Energy Change equals zero

P11 - 6.2 - Total Energy Notes

Find the Potential, Kinetic and Total Energy of 10 kg object at a height of 15 m?

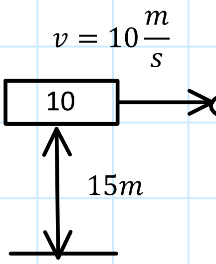


$E_p = mgh$
$E_p = 10(9.8)(15)$
$E_p = 1470\,J$

$E_k = \frac{1}{2}mv^2$
$E_k = \frac{1}{2}(10)(0)^2$
$E_k = 0\,J$

$E_t = E_g + E_k$
$E_t = 1470 + 0$
$E_t = 1470\,J$

Find the E_p, E_k, E_t *of 10 kg object at a height of 15 m at* $v = 10\frac{m}{s}$?

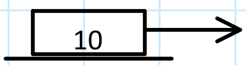


$E_p = mgh$
$E_p = 10(9.8)(15)$
$E_p = 1470\,J$

$E_k = \frac{1}{2}mv^2$
$E_k = \frac{1}{2}(10)(10)^2$
$E_k = 500\,J$

$E_t = E_g + E_k$
$E_t = 1470 + 500$
$E_t = 1970\,J$

What is the Potential, Kinetic and Total Energy of 10 kg object at a h = 0 m at at $v = 10\frac{m}{s}$?

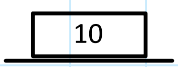


$E_p = mgh$
$E_p = 10(9.8)(0)$
$E_p = 0\,J$

$E_k = \frac{1}{2}mv^2$
$E_k = \frac{1}{2}(10)(10)^2$
$E_k = 500\,J$

$E_t = E_g + E_k$
$E_t = 500 + 0$
$E_t = 500\,J$

What is the Potential, Kinetic and Total Energy of 10 kg object at a height of 0 m?

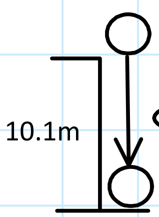


$E_p = mgh$
$E_p = 10(9.8)(0)$
$E_p = 0\,J$

$E_k = \frac{1}{2}mv^2$
$E_k = \frac{1}{2}(10)(0)^2$
$E_k = 0\,J$

$E_t = E_g + E_k$
$E_t = 0 + 0$
$E_t = 0\,J$

What is the Final Velocity, and Time in Flight, of 5 kg ball if dropped from a 10.1 m?



$v_i = 0$

$t = ? = 1.22s$

$v_f = ? = 14.1\frac{m}{s}$

$E_{ki} + E_{pi} = E_{kf} + E_{pf}$

$v_i = 0$	$h_f = 0$
$\frac{1}{2}mv^2 = 0$	$mgh = 0$

$\cancel{E_{ki}} + E_{pi} = E_{kf} + \cancel{E_{pf}}$

$\cancel{m}gh = \frac{1}{2}\cancel{m}v_f^2$ *Mass is Irrelevant!*

$v_f = \sqrt{2gh}$

$v_f = \sqrt{(2)(-9.8)(10.1)}$

$v_f = 14.1\frac{m}{s}$

$v_f = v_i + at$

$t = \frac{v_f}{a}$

$t = \frac{14.1}{9.8}$

$t = 1.44\,s$

$\Delta d = v_i t + \frac{1}{2}at^2$

$t = \sqrt{\frac{2d}{a}}$

$t = \sqrt{\frac{2(10.1)}{9.8}}$

$t = 1.44s$

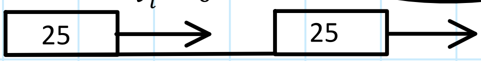
Kinematics –Work Link

P11 - 6.2 - Energy Work Mom. Dyn. Kin Link Notes

Find v_f *of a car of* $m = 25\ kg$*, initially at rest, with a Force of* $125\ N$ *over a* $d = 10m$*?*

$F = 125N$

$v_i = 0$



$d = 10m$

$v_f = ? = 10\frac{m}{s}$

$\Delta E = W$

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

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

$v = \sqrt{\frac{2(125)(10)}{25}}$

$v = 10\frac{m}{s}$

$\Delta E = E_f - E_i$

$\Delta E = E_f - 0$

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

$W = Fd$

How much Work was done on the Object?

$W = Fd$

$W = 125(10)$

$W = 1250\ J$

What was the Objects Acceleration?

$v_f^2 = v_i^2 + 2ad$

$v_i = 0$

$a = \frac{v_f^2}{2d}$

$a = \frac{10^2}{2(10)}$

$a = 5\frac{m}{s^2}$

OR

$v_f = v_i + at$

$a = \frac{v_f}{t}$

$a = \frac{10}{2}$

$a = 5\frac{m}{s^2}$

Check your Answer!

$F = ma$

$125 = 25(5)$

$125N = 125\ N$

How long did it take?

$\Delta d = v_i t + \frac{1}{2}at^2$

$t = \sqrt{\frac{2d}{a}}$

$t = \sqrt{\frac{(2)(10)}{5}}$

$t = 2\ s$

What is the Final Momentum of the Box?

$p = mv$

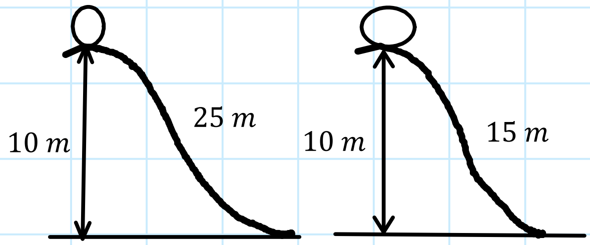
$p = (25)(10)$

$p = 250\frac{kgm}{s}$

And Around And Around We Go!

P11 - 6.3 - Slide Energy Notes

A Ball, initially at Rest, rolls down a 10m high μ = 0 Slide over 25 m. Find "v" at bottom?



Distance is Irrelevant

$$E_{ki} + E_{pi} = E_{kf} + E_{pf}$$

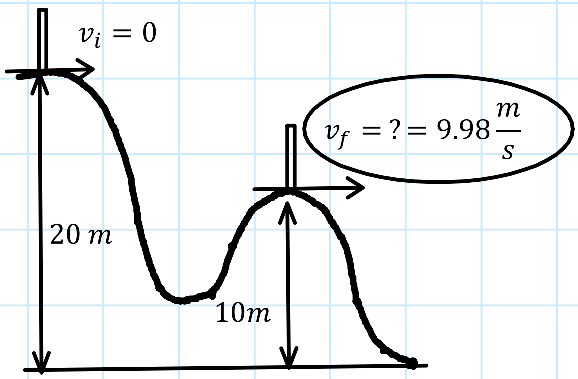
$$mgh_i = \frac{1}{2}mv_f^2$$

$$v_f = \sqrt{2gh}$$

$$v_f = \sqrt{(2)(-9.8)(10.1)}$$

$$v_f = 14.1\frac{m}{s}$$

A 65 kg Skiier, initially at Rest, travels down the Mountain 20 m high as shown.
What is the Velocity at the Second Hump 10 m high?



$$E_{ki} + E_{pi} = E_{kf} + E_{pf}$$

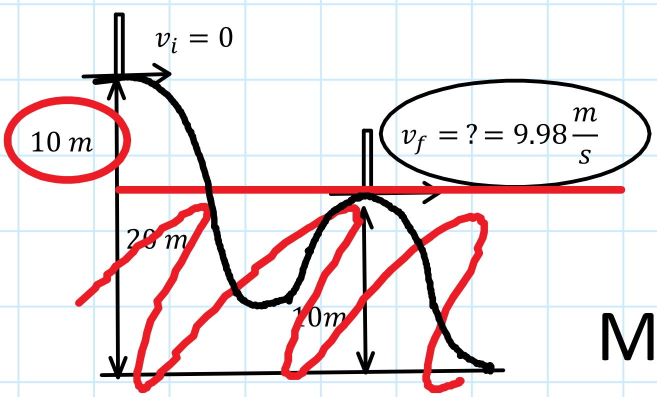
$$mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$v_f = \sqrt{2(gh_i - gh_f)}$$

$$v_f = \sqrt{2((9.8)(20) - (9.8)(10))}$$

$$v_f = 9.98\frac{m}{s}$$

Or



$$E_{ki} + E_{pi} = E_{kf} + E_{pf}$$

$$mgh_i = \frac{1}{2}mv_f^2$$

$$v_f = \sqrt{2gh}$$

$$v_f = \sqrt{2(9.8)(10)}$$

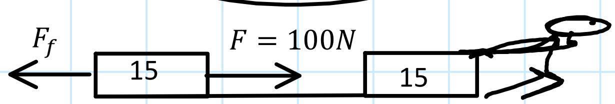
$$v_f = 9.98\frac{m}{s}$$

Move the ground up

P11 - 6.4 - Work Trig Notes

What is the work done on an Object with a Force of 100 N over a distance of 20 m. $\mu = 0.2$

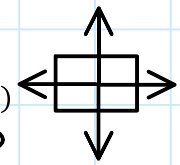
$W = ? = 200J$



$d = 20m \quad \mu = 0.2$

FBD

$F_n = 147N$



$F_p = 100N$

$F_f = \mu F_n$
$F_f = 0.2(147)$
$F_f = 29.4N$

$F_g = mg$
$F_g = 15 \times 9.8$
$F_g = 147\ N$

$W_f = Fd$
$W_f = 29.4(20)$
$W_f = 588J$

Work by Friction

$W_p = Fd$
$W_p = 100(20)$
$W_p = 2000J$

Work by pull

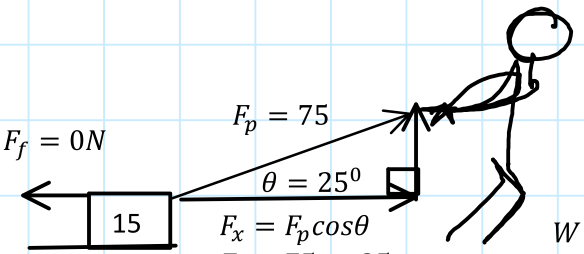
$W_n = W_p - w_f$
$W_n = 2000 - 588$
$W_n = 1412J$

Net Work

$F = ma$
$F_p - F_f = ma$
$100 - 29.4 = 15a$
$a = 4.71\frac{m}{s^2}$

$W_n = Fd$
$W_n = mad$
$W_n = 15(4.71)(20)$
$W_n = 1412J$

Find "W" on an 15kg object with F = 75N at an angle of 25^0 *see below over a d = 20 m.* $\mu = 0.$



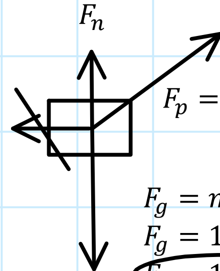
$\mu = 0$
$d = 20m$

$F_x = F_p cos\theta$
$F_x = 75cos25$
$F_x = 67.97N$

$W = F_{||}d$
$W = 67.97(20)$
$W = 1359.46\ Nm$

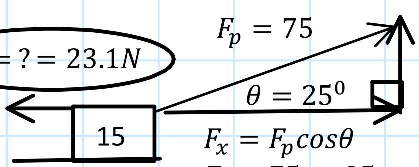
Work by Pull

FBD



$F_g = mg$
$F_g = 15 \times 9.8$
$F_g = 147\ N$

Find Net "W" $\mu = 0.2$ *, see above!*



$\mu = 0.2$
$d = 20m$

$F_x = F_p cos\theta$
$F_x = 75cos25$
$F_x = 67.97N$

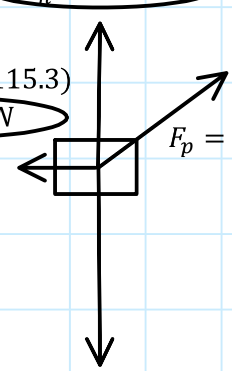
$F_y = F_p sin\theta$
$F_y = 75sin25$
$F_y = 31.69$

Logic

FBD

$F_n = mg - F_y$
$F_n = 147 - 31.69$
$F_n = 115.3$

$F_f = \mu F_n$
$F_f = 0.2(115.3)$
$F_f = 23.1N$



$F = ma$
$F_{px} - F_f = ma$
$67.97 - 29.4 = 15a$
$a = 2.57\frac{m}{s^2}$

$W_n = Fd$
$W_n = mad$
$W_n = 15(2.57)(20)$
$W_n = 771.46J$

$F_g = mg$
$F_g = 15 \times 9.8$
$F_g = 147\ N$

P11 - 6.5 - Power/Efficiency Notes

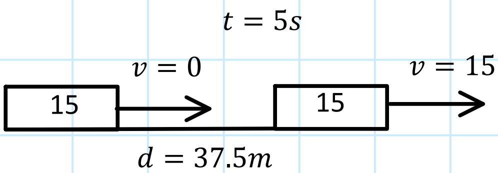
$Power: The\ ability\ to\ do\ Work\ in\ Watts$

$How\ much\ Power\ if\ 30\ J\ of\ Work\ is\ done\ on\ an\ object\ for\ 5s?$

$$P = \frac{W}{t}$$
$$P = \frac{30}{5}$$
$$P = 6\ W$$

$$\boxed{P = \frac{W}{t}} \qquad \boxed{P = \frac{J}{s} = W}$$

$Find\ \text{"P"}\ it\ takes\ a\ Motor\ to\ Push\ 15\ kg\ object\ from\ rest\ to\ 15\frac{m}{s}\ over\ a\ d = 37.5\ m\ in\ 5\ s?$



$$W = Fd$$
$$W = Fd$$
$$W = 45(37.5)$$
$$W = 1687.5\ J$$

$$P = \frac{W}{t}$$
$$P = \frac{1687.5}{5}$$
$$P = 337.5\ W$$

$$v_f = v_i + at$$
$$v_f = at$$
$$a = \frac{v_f}{t}$$
$$a = \frac{15}{5}$$
$$a = 3\frac{m}{s^2}$$

$$F = ma$$
$$F = 15(3)$$
$$F = 45\ N$$

$$d = v_i + \frac{1}{2}at^2$$
$$d = \frac{1}{2}(3)(5)^2$$
$$d = 37.5m!$$

$Dynamics - Work - Power - Kinematics\ Link$

$What\ is\ the\ Efficiency\ of\ the\ Motor\ if\ it\ says\ 500\ W\ on\ the\ side?$

$$E_{ff} = \frac{P_{out}}{P_{in}}$$
$$E_{ff} = \frac{375}{500}$$
$$E_{ff} = 75\%\ Efficient$$

$$\boxed{E_{ff} = \frac{Power\ Out}{Power\ In}}$$