NATIONAL UNIVERSITY OF SCIENES & TECHNOLOGY

Applied Physics (PHY-102)

Assignment # 1

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Class: BEE-12-C

CMS ID: 345834

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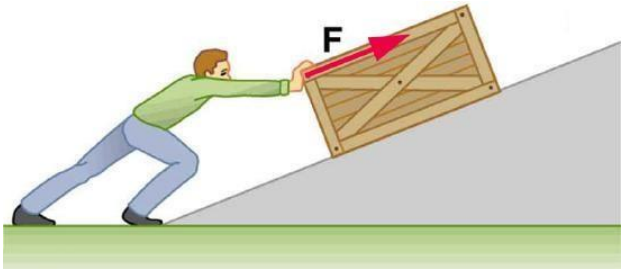
1) (a) Calculate the work done on a 1500-kg elevator car by its cable to lift it 40.0 m at constant speed, assuming friction averages 100 N.

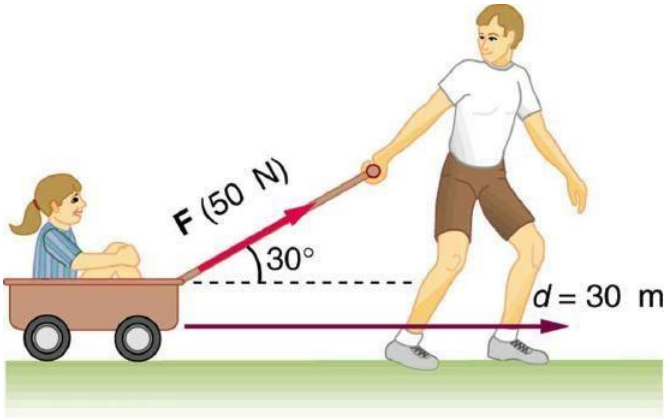
(b) What is the work done on the lift by the gravitational force in this process?

(Answer: (a)5.92×10^5 J (b) -5.88×10^5 J)

2) Calculate the work done by an 70-kg man who pushes a crate 5.00 m up along a ramp that makes an angle of 30 º with the horizontal. (As shown in figure below) He exerts a force of 600 N on the crate parallel to the ramp and moves at a constant speed. Be certain to include the work he does on the crate and on his body to get up the ramp. (Answer: 3.14×10^3 J)



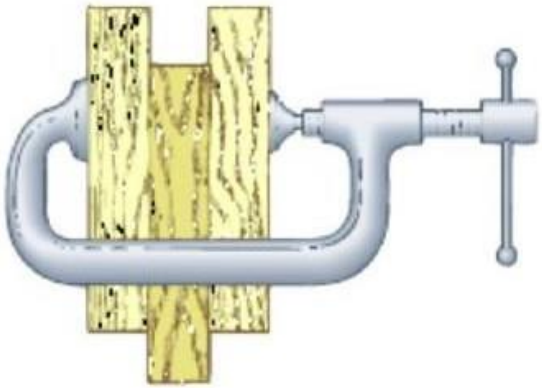
3) How much work is done by the boy pulling his sister 30.0 m in a wagon as shown in figure below? Assume no friction acts on the wagon.



4) A hydroelectric power facility converts the gravitational potential energy of water behind a dam to electric energy. What is the gravitational potential energy relative to the generators of a lake of volume 50.0 km^3 (mass = 5.00×10^{13} kg), given that the lake has an average height of 40.0 m above the generators?

5) The board sandwiched between two other boards in figure weighs 95.5 N. If the coefficient of friction between the boards is 0.663, what must be the magnitude of the compression forces (assume horizontal) acting on both sides of the center board to keep it from slipping?

6) A 400 N wagon is at rest on a carpeted floor. If the coefficients of friction are 0.6 static and



0.4 kinetic, what will happen if you push horizontally with 245 N? b) what will be the acceleration of the wagon?

7) A boy pushes a 100 N crate forward with a 40 N force across a level floor (it is sliding across the floor currently). If the coefficients of friction are 0.4 static and 0.3 kinetic, what will be the net force and acceleration of the crate?

8) A crate of weight Fg is pushed by a force P on a horizontal floor. (a) If the coefficient of static friction is μs and P is directed at angle θ below the horizontal, show that the minimum value of P that will move the crate is given by

(b) Find the minimum value of P that can produce motion when $\mu s = 0.400$, $Fg = 100$ N, and $\theta = 0°, 15.0°, 30.0°, 45.0°$, and $60.0°$.

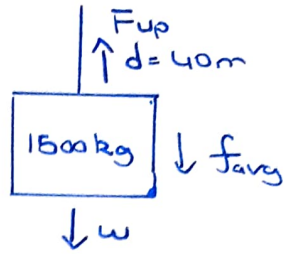
(1)

a) $m = 1500\,kg$

$g = 9.8\,m/s^2$

$d = 40\,m$

$f_{avg} = 100\,N$



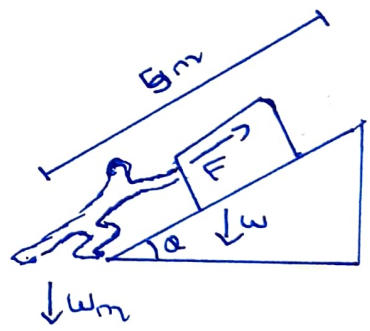
- $w = mg$
  $= (1500)(9.8)$
  $= 14700\,N$

- $F_{up} = w + f_{avg}$
  $= 14700 + 100$
  $= 14800\,N$

Work $= W_{up} = F_{up} d \cos\theta$
$= (14800)(40)\cos(0)$
$= 5.92 \times 10^5\,J$

b) $W_{down} = w d \cos\theta$
$= (14700)(40)\cos(180)$
$= -5.88 \times 10^5\,J$

(2)



$m_m = 70\,kg$

$d = 5m$

$\vec{F} = 600\,N$

$\theta = 30°$

$g = 9.8\,m/s^2$

Work done on crate:

$W_c = \vec{F} d$
$= (600)(5)$
$= 3000\,J$

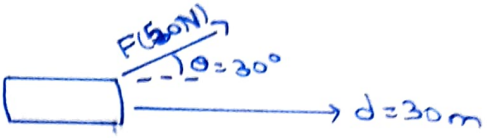
Work done on man:

$W_m = w_m \cdot d\sin\theta \Rightarrow mmg\,d\sin\theta$
$= (70)(9.8)(5)\sin(30)$
$= 1715\,J$

$W_T = W_m + W_c$

$= 4715\ J$

③



$F = 50N$

$\theta = 30°$

$d = 30m$

$W = Fd\cos\theta$

$= (50)(30)\cos(30)$

$= 1299\ J$

④

$m = 5 \times 10^{13}\ kg$

$g = 9.8\ m/s^2$

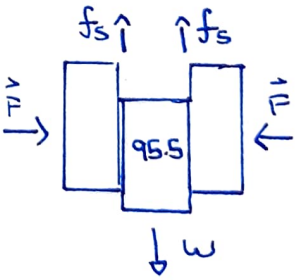
$h = 40m$

$P = mgh$

$= (5 \times 10^{13})(9.8)(40)$

$= 1.96 \times 10^{16}\ J$

⑤



$\mu_s = 0.663$

$m = 9.55\ kg$

$w = 95.5N$

$w - 2f_s = 0$

$2f_s = w$

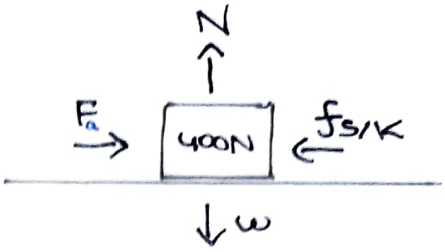
$2(\mu_s N) = w$

$N = \vec{F} = \frac{w}{2\mu_s}$

$= \frac{95.5}{2(0.633)}$

$= 75.4N$

⑥



$F_a = 245\,N$

$W = 400N = \vec{N}$

$\mu_s = 0.6$

$\mu_k = 0.4$

$f_s = \mu_s \vec{N}$

$= 0.6(400)$

$= 240$

$f_k = \mu_k \vec{N}$

$= 0.4(400)$

$= 160$

- For accel., we use f_k

$F_T = (F_a - f_k) = 245 - 160$

$= 85N$

$F_T = ma$

$a = m\backslash 1 \cdot F = F_T/m$

$= \frac{85}{40} = 2.1\ m/s^2$

⑦

$F_a = 40N$

$W = 100N$

$m = 10N$

$\mu_s = 0.4 \qquad \mu_k = 0.3$

$F_T = F_a - f_k$

$= 40 - (0.3)(100)$

$= 40 - 30$

$= 10N$

$F_T = ma$

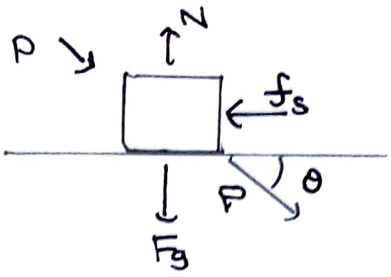
$a = \frac{F_T}{m}$

$= \frac{10}{10}$

$= 1\ m/s^2$

(8)

a)



In vertical:

$N = F_g + P\sin\theta$ ①

$P\cos\theta = f_s$ ②

$P\cos\theta = \mu_s N$

$P\cos\theta = \mu_s (F_g + P\sin\theta)$ ∴ From ①

$P\cos\theta = \mu_s F_g + \mu_s P\sin\theta$

$P\cos\theta - \mu_s P\sin\theta = \mu_s F_g$

$P(\cos\theta - \mu_s \sin\theta) = \mu_s F_g$

Dividing by $\cos\theta$

$$\frac{P(\cos\theta - \mu_s \sin\theta)}{\cos\theta} = \frac{\mu_s F_g}{\cos\theta}$$

$P(1 - \mu_s \tan\theta) = \mu_s F_g \sec\theta$

$$P = \frac{\mu_s F_g \sec\theta}{1 - \mu_s \tan\theta}$$

$\theta = 0$; $P = 40.0\ N$

$\theta = 15°$; $P = 46.4\ N$

$\theta = 30°$; $P = 60.05\ N$

$\theta = 45°$; $P = 94.28\ N$

$\theta = 60°$; $P = 260\ N$