Application of Dot Product & Cross Product May 15/2018

Mechanical work is the dot product of force and displacement vectors.

$$W = \vec{F} \cdot \vec{d} = |\vec{F}||\vec{d}|cos\theta$$

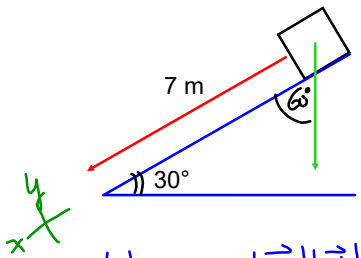
Force is measured in Newtons (N), and displacement in metres (m). Work has units of Joules (J).

Notes:
(1) This determines the work done by a particular force. There could be other forces acting on an object which are also affecting its motion.

(2) Negative work means the force actually opposes the motion of the object.

May 13-9:47 PM

Ex.1 A 20 kg box is placed at the top of a 7m long ramp inclined at 30° to the horizontal. Find the work done by gravity as the box slides down the ramp.



$F_g = mg$

$g = 9.8\ N/kg$

$W_{gravity} = |\vec{F_g}||\vec{d}|\cos\theta$

$= \left|20kg\ \frac{9.8N}{kg}\right||7m|\cos 60°$

$= (196\ N)(7m)\left(\frac{1}{2}\right)$

$= 686\ Nm$

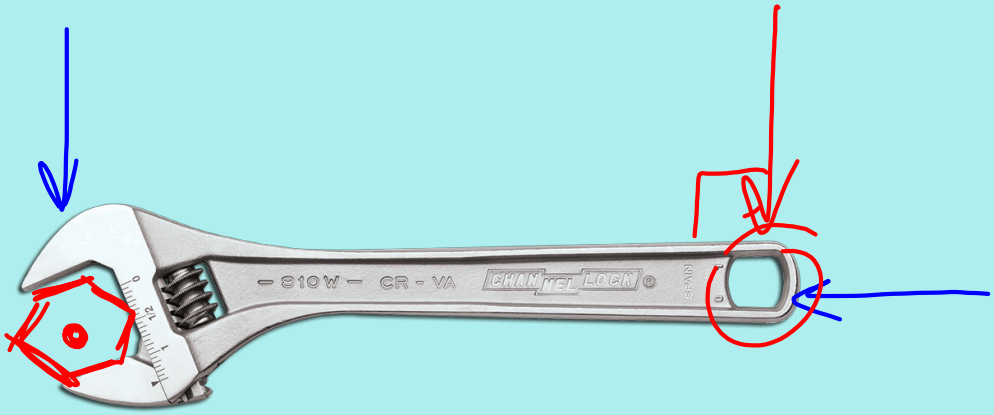
$= 686\ J$

∴ gravity does 686 J of work moving the box.

May 21-9:59 PM

Torque is a measure of how strongly an applied force will tend to rotate, or twist, an object.

It depends on the force and the effectiveness in which the force is applied.

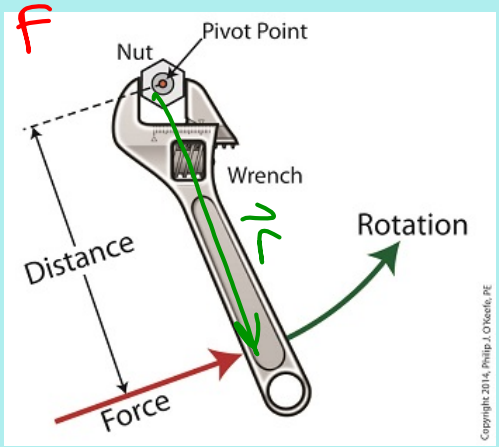


May 13-10:00 PM

Torque is a measure of how strongly an applied force will tend to rotate, or twist, an object.

It depends on the force and the effectiveness in which the force is applied.

$\vec{\tau} = \vec{r} \times \vec{F}$



May 13-10:00 PM

Torque is a measure of how strongly an applied force will tend to rotate, or twist, an object.

$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$|\vec{\tau}| = |\vec{r}||\vec{F}|sin\theta$$

where $\vec{F}$ is the applied force, Newtons (N)

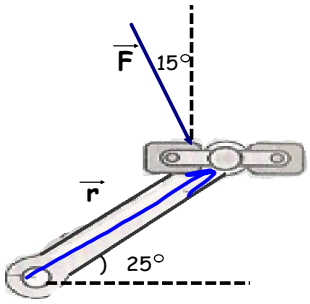
$\vec{r}$ is the moment arm, a vector from the point of rotation to the applied force, measured in metres (m)

$\vec{\tau}$ is the torque, in Newton-metres (N m)

θ is the angle between the applied force and the moment arm

May 13-10:00 PM

Ex.2 Find the magnitude of the torque produced by a cyclist exerting a force of 115N on a pedal in the position shown, if the shaft of the pedal is 16cm long.

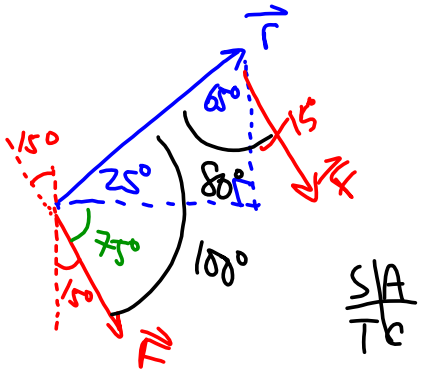


$|\vec{\tau}| = |\vec{r} \times \vec{F}|$

$= |\vec{r}||\vec{F}| \sin\theta$

$= (0.16m)(115N)\sin 100°$

$\doteq 18.12$ Nm



S/A
Tc

May 9-8:36 AM

Assigned Work:

p.414 # 1, 3, 5, 6, 8, 10
+
Handout (optional, posted online)
17. 14 13.

17. 30N in dir $(-2,1,5) \Rightarrow \vec{F}$

$\vec{d}$ from A(2,1,5) to B(3,-1,2)

$\vec{d} = \overrightarrow{OB} - \overrightarrow{OA} = \overrightarrow{AB}$

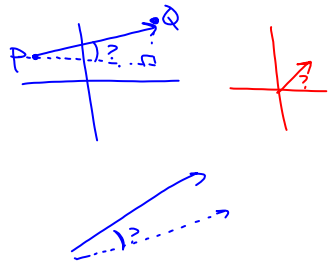
$\vec{F}$ = mag [dir]

= 30N [?]

$= 30N \dfrac{(-2,1,5)}{|(-2,1,5)|}$

$W = \vec{F} \cdot \vec{d}$

16.



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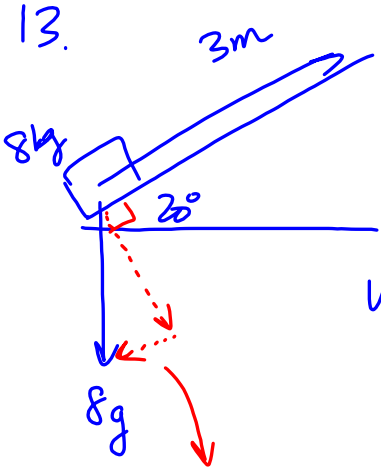
13.



$W_{person} = -W_g$

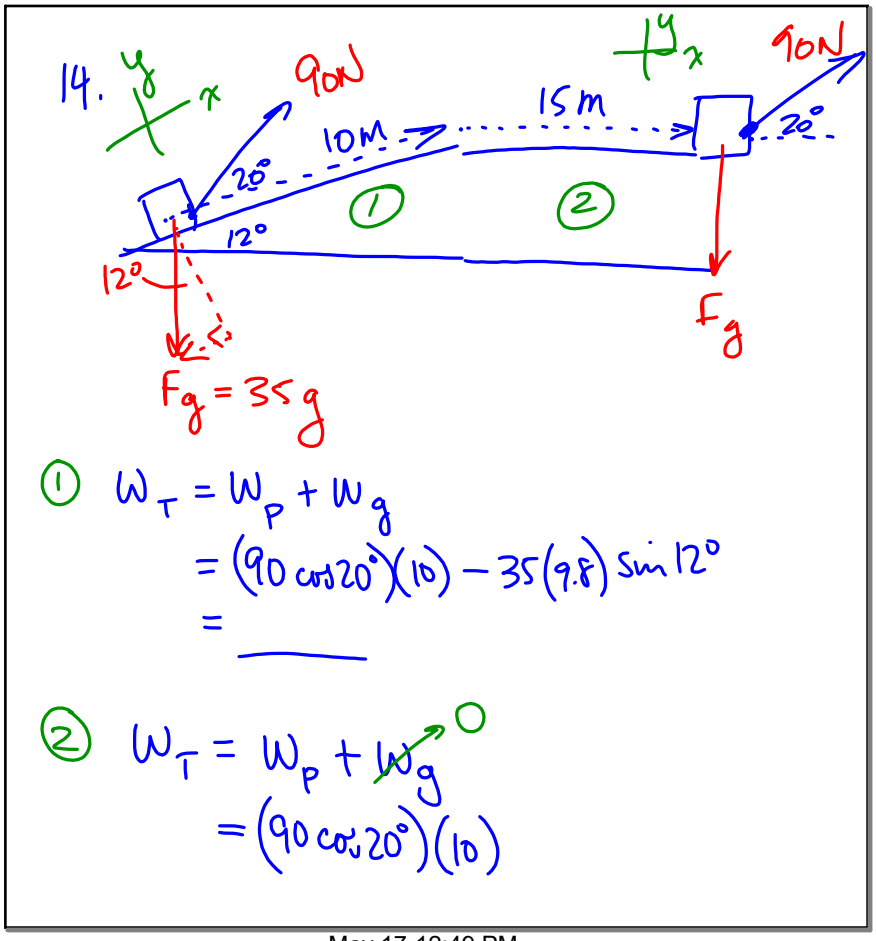
F_{gx} opposes movement

→ does negative work

$W_g = (F_{gx})(3)$

negative

May 17-12:43 PM



① $W_T = W_P + W_g$

$= (90\cos 20°)(10) - 35(9.8)\sin 12°$

$=$ _____

② $W_T = W_P + W_g$ ($W_g = 0$)

$= (90\cos 20°)(10)$

May 17-12:49 PM