Torque and Drive Systems

Torque is the amount of turning produced by a force. The turning or twisting action exerted by a force or number of forces will cause or tend to cause rotary motion.
Drive shafts in cars, tools turning, belt-and-pulley systems, etc. are all affected by torque.

A simple example of this is when the propeller of a model builder's toy boat connected to a rubber band is twisted by torsion forces. When the propeller is released, the rubber band, having been under the twisting effect, releases energy to drive the boat through the water.

Example 1
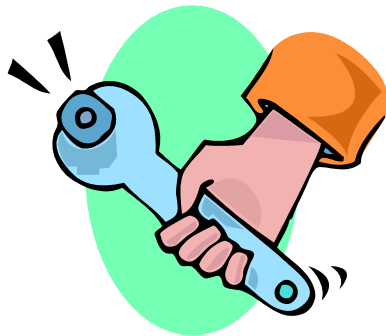How much torque is required to tighten the nut if the force required is 45 N and the radius of the tool is 200 mm.

Figure 1

$$\textit{Torque} = \textit{force} \times \textit{radius}$$
$$= 45 \textit{ N} \times 200 \textit{ mm}$$

Power

Example 3
The effective pull on a belt drive is 420 N when driving a 500mm diameter pulley. The speed of rotation is 220 revolutions per minute. Find the power.

n = 220 rpm = 220/60 revs/s
force = 420N
radius = 250mm

$$\text{Power} = 2\pi nT$$
$$= 2 \text{ x } 3.14 \text{ x } (220/60) \text{ x } (420 \text{ x } 0.25)$$
$$= 2417\text{W}$$

Torque: task 1

(a) Calculate the power transferred if a 230mm diameter pulley wheel revolves at 25 revolutions per second. The pulley tension force is 200N.

(b) A shaft transmits 18 kW when rotating at 200 rpm. What is the torque in the shaft?

(c) A railway traction motor develops 150 kW when the train moves along the track. The rail wheel rotates at 1500 rpm. Find the torque in the driving axle.

(d) An electric motor exerts a torque of 23 Nm and rotates at 2800 rpm. Find the power of the motor.

(e) The effective pull on a belt is 360 N when driving a 400mm diameter pulley. The speed of rotation is 250 rpm. Calculate the power.

(f) During a machining test on a lathe, the tangential force on the cutting tool was found to be 220 N. If the work-piece diameter was 120 mm, what was the torque on the lathe spindle?