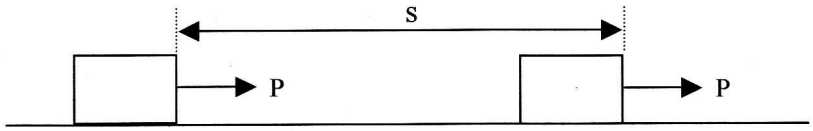
Work, Energy and Power

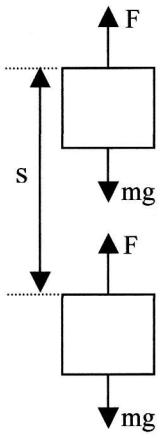
Work



If the point of application of a force of P newtons moves through a distance s metres in the direction of the force, then the work done is

P x s joules

The unit of work is the joule, abbreviated J.



Work done against gravity
In order to raise a mass of m kg vertically at a constant speed, a force mg N must be applied vertically upwards to the mass. In raising the mass a distance s metres, the work done against Gravity will be

mgs J

Eg1 Find the work done against gravity when a body of mass 3.5kg is raised through a vertical distance of 6m.

General motion at constant speed
In order to move a body at a constant speed, a force equal in magnitude to the forces of resistance acting on the body, has to be applied to the body.

Eg2 A block of wood is pulled a distance of 4m across a horizontal surface against resistances totalling 7.5N. If the block moves at a constant velocity, find the work done against the resistances.

Eg3 A horizontal force pulls a mass of 2.25kg a distance of 8m across a rough horizontal surface, $\mu=1/3$. The body moves with constant velocity and the only resisting force is due to friction. Find the work done against friction.

Work done against gravity and friction
When a body is pulled at a uniform speed up the surface of a rough inclined plane, work is done both against gravity and against the frictional force which is acting on the body due to the contact with the rough surface of the plane.

Eg4 A rough surface is inclined at $\tan^{-1}(7/24)$ to the horizontal. A body of mass 5kg lies on the surface and is pulled at a uniform speed a distance of 75cm up the surface by a force acting along a line of greatest slope. If $\mu=5/12$, find (a) the work done against gravity, (b) the work done against friction..

Forces at an angle to the direction of motion
For a force at an angle to the direction of motion,

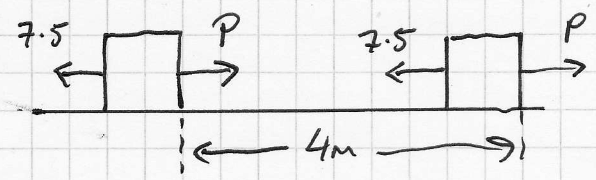
Work done = component of force in direction of motion x distance moved in the same direction

Eg5 A packing case is pulled across a smooth horizontal floor by a force of magnitude 20N inclined at 30° to the horizontal. Find the work done by the force in moving the packing case a distance of 10m.

Exercise 3A Pg 62 Odd's

Eg1 $Wd = 3.5 \times 9.8 \times 6 = \underline{205.8\,J}$

Eg2

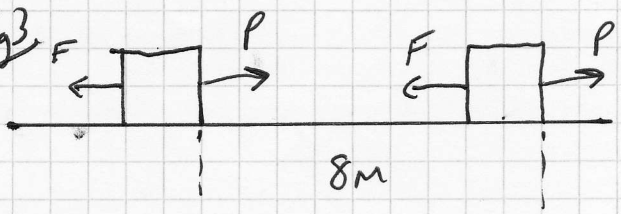


$P - 7.5 = 0$

$P = 7.5$

$Wd = 7.5 \times 4 = \underline{30\,J}$

Eg3



Now $P - F = 0$

$F = \mu R_N$

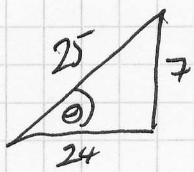
$F = \frac{1}{3} \times 2.25 \times 9.8 = 7.35N$

$\therefore P = 7.35N$

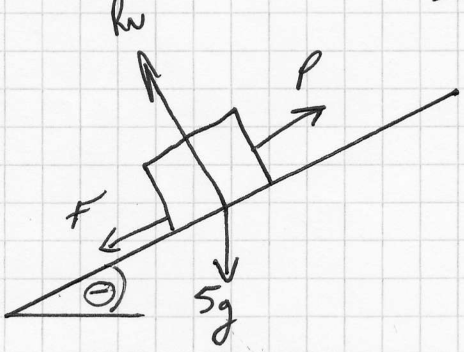
Hence $wd = 7.35 \times 8 = \underline{58.8\,J}$

Eg

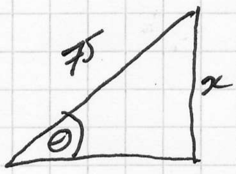
$\tan\theta = \frac{7}{24}$



$\sin\theta = \frac{7}{25}$ $\cos\theta = \frac{24}{25}$



(a) For wd v's g, need to calc vert dist trav'd



$\frac{x}{75} = \sin\theta = \frac{7}{25}$

$x = \frac{7}{25} \times 75 = 21cm$

$wd = 5g \times 0.21 = \underline{10.29\,J}$

(b) For wd v's fric, need to calc F

~~[illegible]~~

$R_N = 5g\cos\theta$ — (2)

$F = \mu R_N$ — (3)

* P works against both friction + gravity. Need to calculate wd's separately.

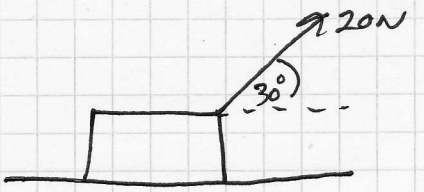
in (3) $F = \frac{5}{12} \cdot 5g \cdot \frac{24}{25} = 19.6$

in (1) ~~[illegible]~~

~~[illegible]~~ ~~this would be the total w.d. = 10.29 + 4.4~~

wd v's Frict $= 0.75 \times 19.6 = \underline{14.7\,J}$

Q5



$Wd = 20 \cos 30 \times 10 = 173.2\ J$