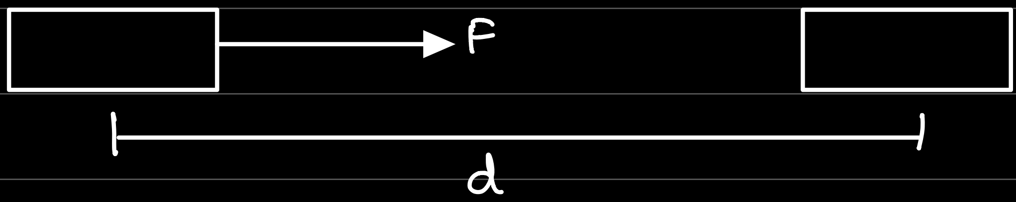
WORK - POWER - ENERGY.

$\boxed{\text{WORK}}$ Work is said to be done when a force displaces an object in its direction

parallel

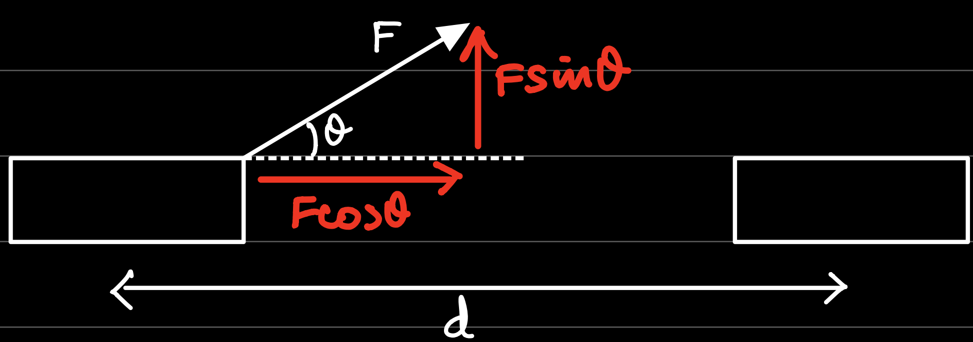


$$\text{WORK DONE} = \underbrace{F \times d}_{\text{must be parallel to each other}}$$

UNIT = Joules (J)

work done = 0 J

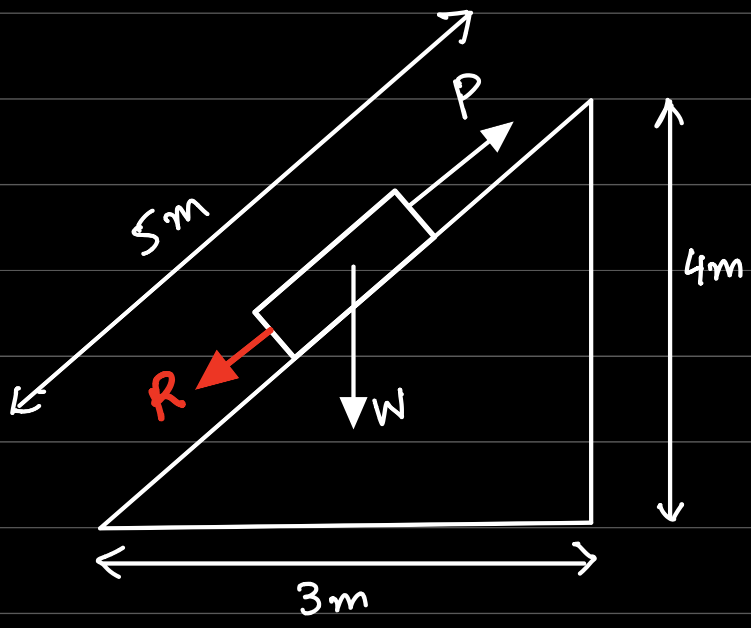
Start point = end point ⟶ disp = 0



$$W = (F\cos\theta) \times (d)$$

FORCE AND DISPLACEMENT MUST BE PARALLEL.

ARROWS CAN BE POINTING AWAY.



(i) Workdone by Force P in pulling object from bottom to top.

$W = F \times d$

$W = (P) \times (5)$

(ii) Workdone against gravity

weight

$W = F \times d$

$W = (W) \times (4)$

(iii) Workdone against resistive forces.

$W = F \times d$

$W = (R) \times (5)$

ENERGY

GRAVITATIONAL POTENTIAL ENERY	KINETIC ENERGY.
Due to height of object	Due to speed of object.
$PE = mgh$	$KE = \frac{1}{2} m v^2$
Units = Joules (J)	Units = Joules (J)

POWER

$$\boxed{\text{Power} = \frac{\text{Workdone/Energy}}{\text{time}}} \quad \frac{J}{s}$$

$$P = \frac{W}{t} = \frac{F \times d}{t} = F \times v$$

$$\boxed{P = F v}$$

UNITS : WATTS (W) OR J/s

TRICKS :

1) KW means 1000 W
5 KW means 5000 W
P KW means 1000 P W

2) They use units
J/s or $J s^{-1}$
instead of Watts.

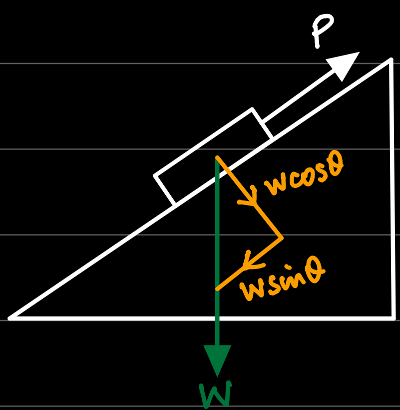
F is different in all of these four formulas.

$F = ma$	$W = F \times d$	$P = F \times v$	$F = \mu R$
$\downarrow$	$\downarrow$	$\downarrow$	$\downarrow$
Fwd - Bwd	Desired force whose work done is to be found.	Driving force	Maximum Friction

FORWARD FORCE

Any force acting in the direction of motion

Box is moving upwards



Fwd force = P

Bwd force = $W\sin\theta$

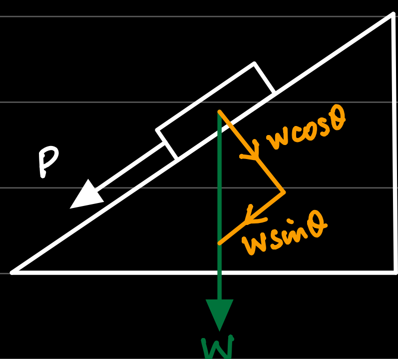
DRIVING FORCE

→ Has to be an external force

→ Acts in same direction as direction of motion

→ Cannot include weight (W) or components ($W\sin\theta$, $W\cos\theta$)

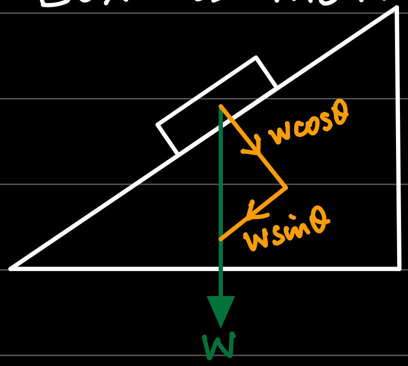
Box is moving downwards.



Fwd Force = P + $W\sin\theta$

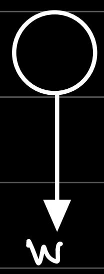
Driving Force = P

Box is moving down.



Fwd = $W\sin\theta$

Driving force = 0



Ball is falling freely under gravity.

Fwd force = w

Driving force = 0

$\boxed{\text{TYPE1}}$ QUESTION WILL DISCUSS

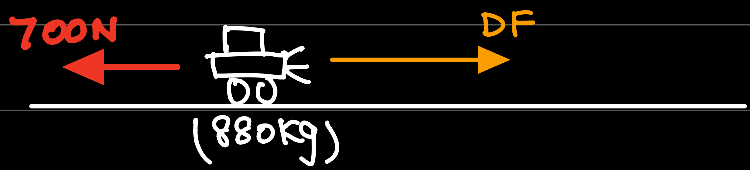
$\boxed{\text{FORCE}}$, $\boxed{\text{ACCELERATION}}$, $\boxed{\text{POWER}}$

$$\boxed{\text{Fwd} - \text{Bwd} = ma}$$

$$\boxed{\begin{array}{l} P = F_{\text{Driving}}\, v \\ P = (DF)v \end{array}}$$

Apply both of these at same time and find unknown.

46 A car of mass 880 kg travels along a straight horizontal road with its engine working at a constant rate of P W. The resistance to motion is 700 N. At an instant when the car's speed is 16 m s^{-1} its acceleration is 0.625 m s^{-2}. Find the value of P. [4]



Power = P

acc = 0.625

v = 16

Fwd − Bwd = ma

DF − 700 = 880(0.625)

DF = 1250

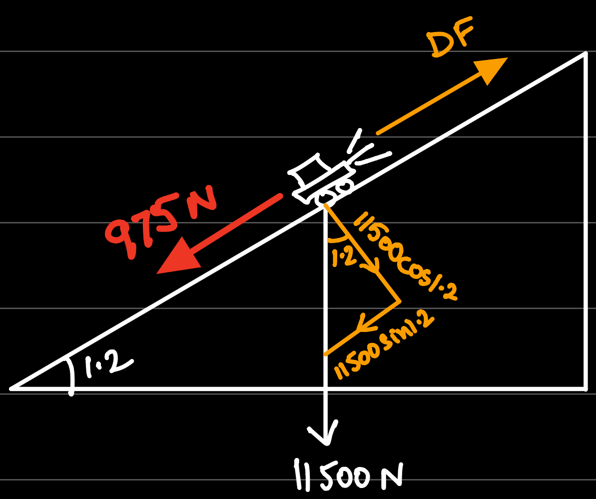
P = (DF)(v)

P = (1250)(16)

P = 20,000 W

W = 11500

25 A car of mass 1150 kg travels up a straight hill inclined at 1.2° to the horizontal. The resistance to motion of the car is 975 N. Find the acceleration of the car at an instant when it is moving with speed 16 m s^{-1} and the engine is working at a power of 35 kW. [4]



a = ?

v = 16

P = 35 KW = 35000 W

Fwd − Bwd = ma

DF − 975 − 11500 sin 1.2 = 1150a

P = (DF) v

35000 = (DF)(16)

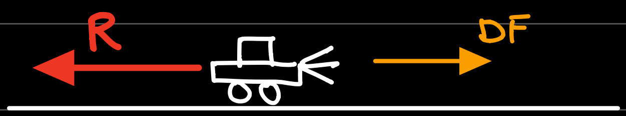
DF = 2187.5

2187.5 − 975 − 11500 sin 1.2 = 1150a

a = 0.8449.

Power = 1000 P

67 A car has mass 800 kg. The engine of the car generates constant power P kW as the car moves along a straight horizontal road. The resistance to motion is constant and equal to R N. When the car's speed is 14 m s^{-1} its acceleration is 1.4 m s^{-2}, and when the car's speed is 25 m s^{-1} its acceleration is 0.33 m s^{-2}. Find the values of P and R. [6]



800 kg

$v = 14$, $a = 1.4$

Power $= 1000P$

Fwd − Bwd = ma

$DF - R = 800(1.4)$

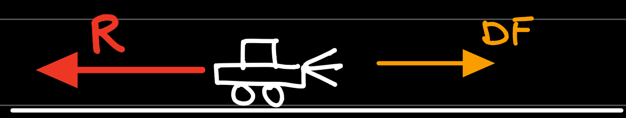
$\frac{1000P}{14} - R = 1120$

$\boxed{R = \frac{1000P}{14} - 1120}$

$P = (DF)v$

$1000P = DF(14)$

$\boxed{DF = \frac{1000P}{14}}$



800 kg

$v = 25$, $a = 0.33$

Power $= 1000P$

Fwd − Bwd = ma

$DF - R = 800(0.33)$

$40P - R = 264$

$\boxed{R = 40P - 264}$

$P = (DF)v$

$1000P = DF(25)$

$DF = \frac{1000P}{25}$

$\boxed{DF = 40P}$

NOW SOLVE SIMULTANEOUS.

$$\frac{1000P}{14} - 1120 = 40P - 264$$

$$\frac{1000P}{14} - 40P = 1120 - 264$$

$$\frac{220}{7}P = 856$$

$P = 27.236$, $R = 40(27.236) - 264$

$R = 825.45$

TYPE 2 **WORK DONE** or **ENERGY**

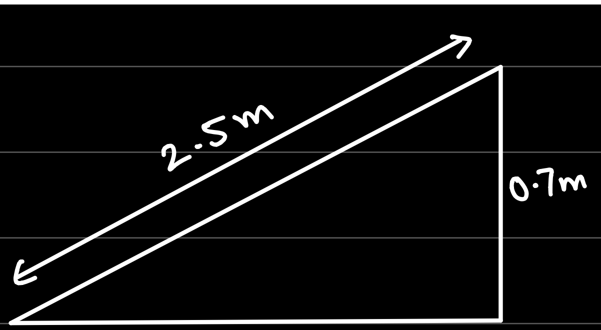
MARKS : Range from 1 Mark to 9 marks.

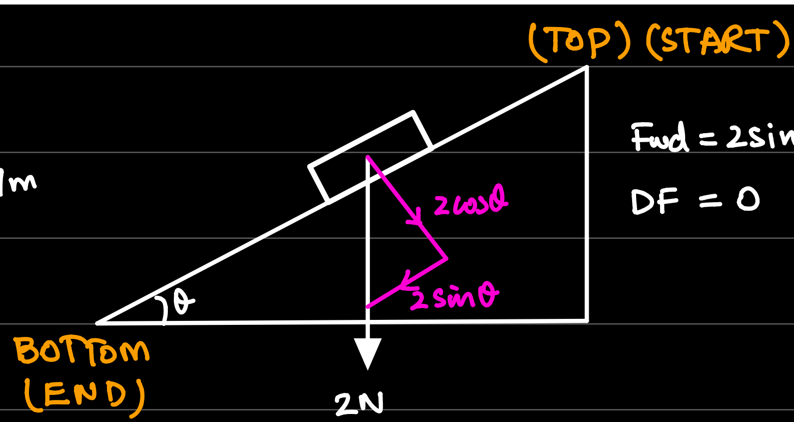
BEFORE		AFTER
PE = KE = Workdone by Driving force =	=	PE = KE = Workdone against friction =

1 The top of an inclined plane is at a height of 0.7 m above the bottom. A block of mass 0.2 kg is released from rest at the top of the plane and slides a distance of 2.5 m to the bottom. Find the kinetic energy of the block when it reaches the bottom of the plane in each of the following cases:

(i) the plane is smooth, (No friction) [2]

(ii) the coeff cient of friction between the plane and the block is 0.15. [5]





$F_{wd} = 2\sin\theta$

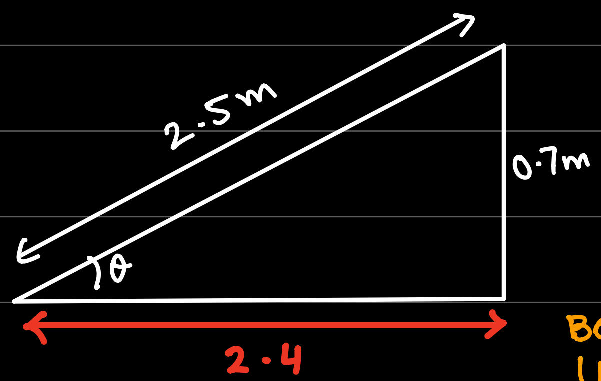
DF = 0

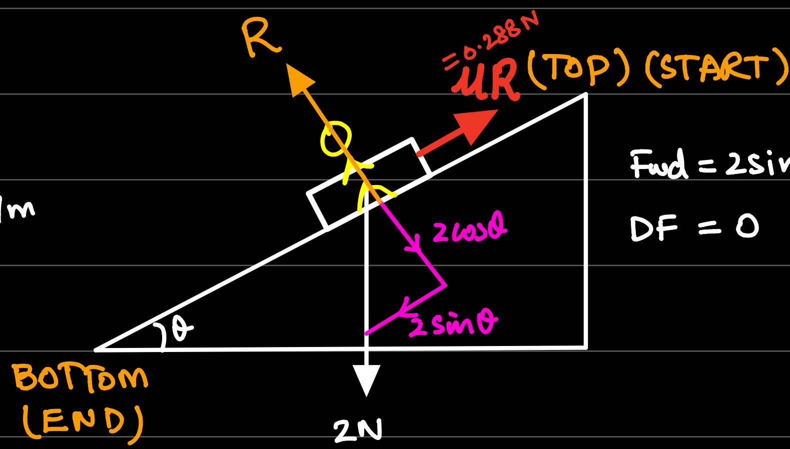
BEFORE		AFTER
TOP		BOTTOM
PE = mgh = (0.2)(10)(0.7) = 1.4 KE = 0 Workdone by Driving force = 0	=	PE = 0 KE = ? Workdone against friction = 0

$1.4 + 0 + 0 = 0 + KE_B + 0$

$KE_B = 1.4\text{ J}$

(iii) PLANE IS ROUGH: $\mu = 0.15$





Fwd = 2sinθ

DF = 0

$$\boxed{\begin{aligned} \sin\theta &= \frac{0.7}{2.5} = \frac{7}{25} \\ \cos\theta &= \frac{2.4}{2.5} = \frac{24}{25} \end{aligned}}$$

Apply up = down to find R

$R = 2\cos\theta$

$R = 2\left(\frac{24}{25}\right) = 1.92$

Apply $F = \mu R$ to find friction.

$F = (0.15)(1.92)$

$F = 0.288$.

BEFORE		AFTER
Top		Bottom
PE = (0.2)(10)(0.7) = 1.4	=	PE = 0
KE = 0		KE = ?
Workdone by Driving force = 0		Workdone against friction = (0.288) × (2.5)

$$1.4 + 0 + 0 = 0 + KE_B + (0.288)(2.5)$$

$$KE_B = 0.68 \text{ J}$$