Q- is it easier to move a box that is sitting on the ground (a) by pulling the box from a rope that makes an angle of 30 with the surface or(b) by pushing the box with the force that makes the same angle (but pointing downward) with the surface?

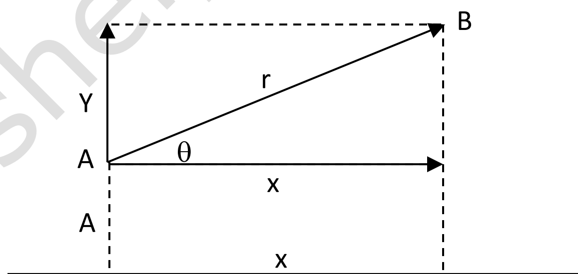
Reading:

It is important in the physics to have clear idea of vectors. The vector quantities cannot be worked out by simple algebra. The addition and subtracting vector quantities is based on the law of parallelogram or triangle law.

A line segment with an arrow mark represents a vector quantity. The length of the segment will represent the magnitude of the vector by choosing some scale (as on graph or a map) like 1 cm = 5 Newton for force or 1 cm = 50 m/s for velocity vector. The direction is denoted be the arrowed line.

A vector has its effect in other directions as well and this effect called projection of the vector. If the sun is overhead and a bird flies from point A to point B by a distance 'r' then its shadow which has to remain with it in a vertical line but cannot leave ground will move by a distance x = r*cos θ and here the displacement vector x is the projection of displacement vector 'r' Similarly every vector has its projection in the direction making angle θ with its direction, equal to (cos θ) times its magnitude.

As we know that cos 90^0 = 0, a vector has no effect in its perpendicular direction. That is why we resolve (break up) a vector in two mutually perpendicular directions so that one component will have no effect on the other and the resultant of the two is the vector itself. And hence we can solve in the two directions separately.



The two components of vector r in this way are the projections x = r*cosθ along x direction and y = r*cos (90^0 - θ) = r*sin θ along y direction.

The vector can also be represented by the product of its magnitude and a unit vector in its direction. If $\hat{\imath}$ and $\hat{\jmath}$ represent unit vectors in x and y directions, then the components of vector r can be represented as x. $\hat{\imath}$ and y.$\hat{\jmath}$ and hence we may write vector $\hat{r}$ as

$$\vec{r} = x\,\hat{\imath} + y\,\hat{\jmath}$$

Similarly, a force F in direction making angle θ with x direction can be written as

$$\vec{F} = F_x\,\hat{\imath} + F_y\,\hat{\jmath}$$

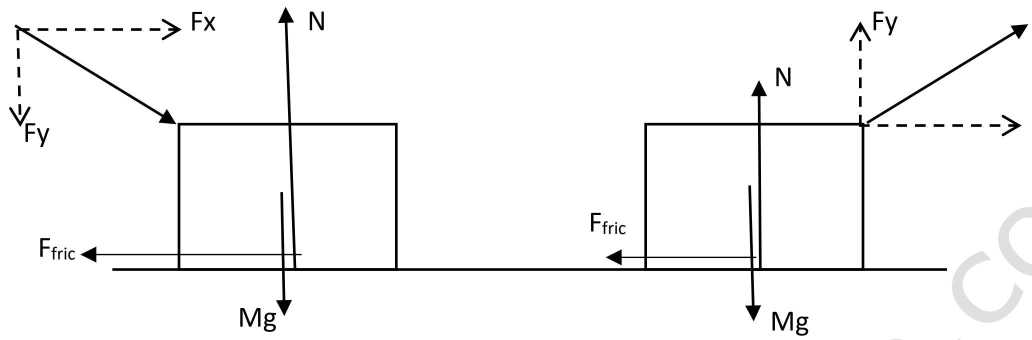
Or $$\vec{F} = F\,cos\theta\ \hat{\imath} + F\,sin\theta\ \hat{\jmath}$$

(Go through the text of vectors now and I think everything will be clear to you)

Now to your question

To slide the box, we need a force equal to the friction force between the box and the ground. As we want to move the box on the surface the horizontal component of the force must be slightly greater than the limiting friction force which is equal to the product of coefficient of friction μ and the normal reaction N.

$F_{fric} = \mu N$



The normal reaction is the force equal and opposite to the resultant of the weight of the box Mg and the vertical component of the force applied.

If we push the box, the vertical component of the force applied will be added to the weight thus creating larger normal reaction and consequently larger limiting friction force.

If we pull the box the vertical component of the force applied will be (upward) subtracted from the weight of the box and thus the normal reaction and hence the limiting friction force will be less.

So, with less friction force it will be easy to move the box by pulling it.