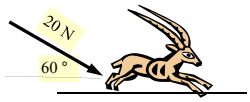
Forces at Angles

SAMPLE PROBLEM

You push on a 60 kg gazelle as shown in the diagram. What is the normal force? What is the acceleration of the gazelle?

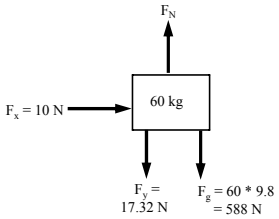


RESOLVE THE VECTOR:

$F_x = 20 \cos 60° = 10$ N (to the right)

$F_y = 20 \sin 60° = 17.32$ N (downward)

DRAW FBD



WRITE NET FORCE EQUATIONS FOR BOTH X AND Y DIRECTIONS

ΣF_x : $F_x = ma_x$

$10 \text{ N} = 60\text{kg } a_x$

ΣF_y : $F_N - F_y - F_g = ma_y$

$F_N - 17.32 \text{ N} - 588 \text{ N} = 60\text{kg } (0)$

USE ΣF_Y TO SOLVE FOR NORMAL FORCE

$F_N - 17.32 \text{ N} - 588 \text{ N} = 60\ (0)$

$F_N = 605.32$ N

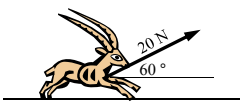
USE ΣF_X TO SOLVE FOR a

$10 \text{ N} = 60\text{kg } a_x$

$a = 0.167 \text{ m/s}^2$

SAMPLE

You **PULL** on a 60 kg gazelle as shown in the diagram. What is the normal force? What is the acceleration of the gazelle?

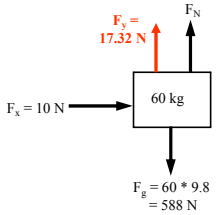


RESOLVE THE VECTOR:

$F_x = 20 \cos 60° = 10$ N (to the right)

$F_y = 20 \sin 60° = 17.32$ N (upward)

DRAW FBD



WRITE NET FORCE EQUATIONS FOR BOTH X AND Y DIRECTIONS

ΣF_x : $F_x = ma_x$

$10 \text{ N} = 60\text{kg } a_x$

ΣF_y : $F_N + F_y - F_g = ma_y$

$F_N + 17.32 \text{ N} - 588 \text{ N} = 60\text{kg } (0)$

USE ΣF_Y TO SOLVE FOR NORMAL FORCE

$F_N + 17.32\ N - 588\ N = 60kg\ (0)$

$F_N = 570.68\ N$

USE ΣF_X TO SOLVE FOR a

$10\ N = 60kg\ a_x$

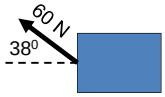
$a = 0.167\ m/s^2$

Solving Force Problems

1. **Resolve the vectors.**
2. **Draw Free Body Diagrams (FBD).**
3. **Write the net force equations.**
4. **Plug in numbers and solve for normal force F_N.**
5. **Determine if the object will move. Is the force applied greater than the static frictional force ($F_x > F_{fs}$)?**
6. **Use F_x and kinetic frictional force (F_{fk}) to solve for a_x.**
7. **Use a kinematic equation as needed.**

Practice

You **PULL** on a 120 kg box of books as shown in the diagram. What is the normal force? What is the acceleration of the box?

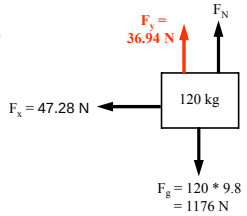


RESOLVE THE VECTOR:

$F_x = 60 \cos 38° = 47.28\ N$ (to the left)

$F_y = 60 \sin 38° = 36.94\ N$ (upward)

DRAW FBD



WRITE NET FORCE EQUATIONS FOR BOTH X AND Y DIRECTIONS

ΣF_x : $-F_x = ma_x$

$-47.28\ N = 120kg\ a_x$

ΣF_y : $F_N + F_y - F_g = ma_y$

$F_N + 36.94\ N - 1176\ N = 120kg\ (0)$

USE ΣF_Y TO SOLVE FOR NORMAL FORCE

$F_N + 36.94\ N - 1176\ N = 120\ (0)$

$F_N = 1139.06\ N$

USE ΣF_X TO SOLVE FOR a

$-47.28\ N = 120kg\ a_x$

$a = -0.394\ m/s^2$