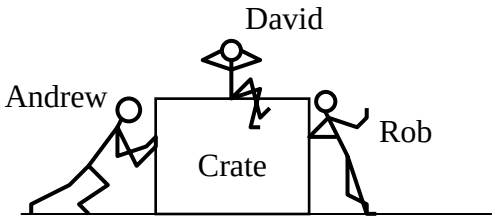
Quiz 8 Physics 201

NAME: _____

DO YOUR OWN WORK and SHOW ALL OF IT!

1) Andrew is pushing a crate along a level floor with ordinary kinetic friction. Andrew has not noticed that David is sitting on top of the crate and Rob is leaning on the other side. The crate has a mass of 48.0 kg. David has a mass of 72.0 kg. Rob is gently pushing on the crate with a constant (horizontal) force of 28.0 N. Andrew is not-so-gently pushing with a force of 418 N. The coefficient of kinetic friction between the crate and the floor is 0.250. The crate starts at rest and Andrew moves it 1.50 m before he quits pushing on it. (The acceleration of objects in free fall is 10.0 m/s^2.)



a) As the crate moves 1.5 m, calculate the work that Andrew does on the crate (the sign is important).

$$(418\ N)(+1.5\ m) = 627\ J$$

b) As the crate moves 1.5 m, calculate the work that Rob does on the crate (the sign is important).

$$(28\ N)(-1.5\ m) = -42\ J$$

c) As the crate moves 1.5 m…

i) what force(s) does the floor exert on the crate?

Normal force and *Friction*

ii) For each of the forces you listed above, calculate the amount of work that the floor does on the crate via that force (the sign is important).

Normal force: no work. Force and displacement are perpendicular.

Friction:

$$f = \mu N = (0.250)\left[(48\ kg + 72\ kg)\ g\right] = 300\ N$$

$$Work = f\ \Delta x = (300\ N)(1.5\ m) = -450\ J$$

d) You probably thought David was being lazy, but maybe he is working, too.

i) The crate (with David on top of it) is speeding up as Andrew pushes it. What force is causing ***David*** to speed up? Explain your reasoning.

Friction. There are two forces on David: the normal force from the crate and friction from the crate. The normal force is perpendicular to the direction of motion so the force that is causing his kinetic energy to increase is friction (static friction, but friction nonetheless).

ii) Given your answer to part i, list the forces that David is exerting on the crate and for each one state whether or not that force contributes to any (positive or negative) net work done on the crate. You don't need to calculate the work.

Normal force: does no work since it is perpendicular to displacement.

Friction: Friction between David and the crate does ***negative work on the crate.*** *(It does positive work on David.)*

e) The forces referred to in parts a, b, and c should allow you to calculate the net force on the system "David plus Crate." Calculate that net force and find the acceleration of David and the Crate.

$$F_{Andrew} - F_{Rob} - f_{floor} = 418\ N - 28\ N - 300\ N = 90\ N$$

$$a = \frac{90\ N}{(48\ kg + 72\ kg)} = 0.75\ m/s^2$$

f) Use your answer to part e to find the net force on David.

$$\sum F_{David} = m_{David}\ a_{David} = (72\ kg)(0.75\ m/s^2) = 54\ N$$

g) Use your answer to part f to calculate the work that David does on the crate while the crate moves 1.5 meters (sign is important).

$$Work = (54\ N)(-1.5\ m) = -81\ J$$

h) Calculate the net work done on the crate as it moves 1.5 m (sign is important).

$$627\ J - 42\ J - 450\ J - 81\ J = 54\ J$$

i) Calculate the speed of the crate after it moved 1.5 meters (it started from rest).

$$54\ J = Net\ Work = \Delta K = K_f - K_i = K_f - 0 = K_f$$

$$54\ J = \frac{1}{2} m\ v^2 \qquad v^2 = \frac{2(54\ J)}{48\ kg} = 2.25\ m^2/s^2$$

$$v = 1.5\ m/s$$