TUTORIAL CHAPTER 3 – DYNAMICS

1. A net force of 255 N accelerates a bike and a rider at 2.20 m/s^2. What is the mass of the bike and rider?

2. How much tension must a rope withstand if it is used to accelerate a 1050 kg car horizontally at 1.2 m/s^2? Ignore friction.

3. What average force is required to stop an 1100 kg car in 8.0 s if it is traveling at 90 km/h?

4. What is the weight of 66 kg astronaut

   (a) on Earth

   (b) on the moon ($g = 1.7\ m/s^2$)

   (c) on Mars ($g = 3.7\ m/s^2$)

   (d) in outer space traveling with constant velocity?

5. A 20.0 kg box rests on a table.

   (a) What is the weight of the box and the normal force acting on it?

   (b) A 10.0 kg box is placed on top of the 20.0 kg box. Determine the normal force that the table exerts on the 20.0 kg box and the normal force that the 20.0 kg box exerts on the 10.0 kg box.

6. A 0.140 kg baseball traveling 45.0 m/s strikes the catcher's mitt, which, in bringing the ball to rest, recoils backward 11.0 cm. What was the average force applied by the ball on the glove?

7. Three blocks on a frictionless horizontal surface are in contact with each other. A force F is applied to block 1 (mass m_1).

   (a) Draw a free body diagram for each block.

   Determine

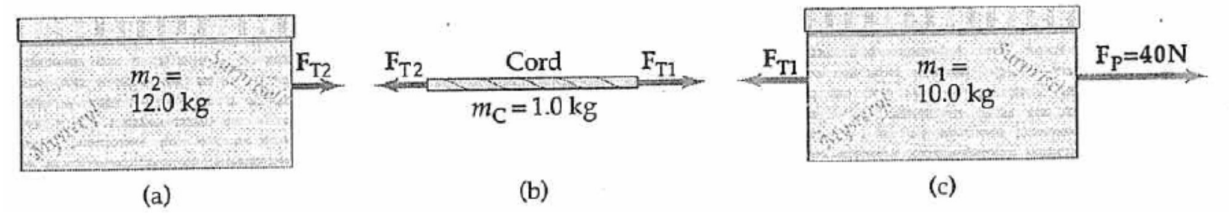
   (b) the acceleration of the system (in terms of m_1, m_2, m_3)

   (c) the net force on each block

   (d) the contact force that each block exerts on its neighbour.

   (e) If $m_1 = m_2 = m_3 = 12.0$ kg and F = 96.0 N, give numerical answers to (b), (c) and (d).

8. Calculate the acceleration of each box and the tension at each of the cord, using the free body diagram shown below.



9. How much tension must a rope withstand if it is used to accelerate a 1200 kg car vertically upward at 0.80 m/s^2? Ignore friction.

10. A person stands on a bathroom scale in a motionless elevator. When the elevator begins to move, the scale briefly reads only 0.75 of the person's regular weight. Calculate the acceleration of the elevator, and find the direction of the acceleration.

11. If the coefficient of kinetic friction between a 35-kg crate and the floor is 0.30, what horizontal force is required to move the crate at a steady speed across the floor? What horizontal force is required if μ_k is zero?

12. A force of 40.0 N is required to start a 5.0 kg box moving across a horizontal concrete floor.

    (a) What is the coefficient of static friction between the box and the floor?

    (b) If the 40.0 N force continues, the box accelerates at 0.70 m/s^2. What is the coefficient of kinetic friction?

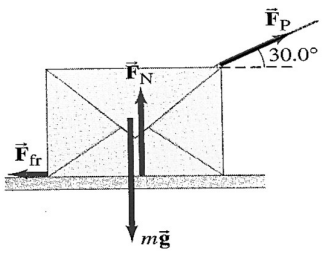
13. A box is given a push so that it slides across the floor. How far will it go, given that the coefficient of kinetic friction is 0.20 and push imparts an initial speed of 4.0 m/s.

14. Two crates of mass 75 kg and 110 kg are in contact and rest on a horizontal surface. A 730 N force is exerted on the 75 kg crate. If the coefficient of kinetic friction is 0.15, calculate

    (a) the acceleration of the system

    (b) the force that each crate exerts on the other.

15. A 10.0 kg box as in figure below is pulled along a horizontal surface by a force F_P of 40.0 N applied at 30.0° angle above horizontal. We assume a coefficient of kinetic friction of 0.30. Calculate the acceleration.



16. A block of mass 1 kg rests in equilibrium on a rough horizontal table is under the action of a force *P* that acts at an angle of 30º to the horizontal, as shown in Figure 2. Given that the magnitude of *P* is 2.53 N, calculate

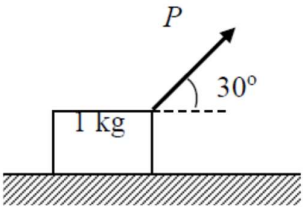


Figure 2

(i) the normal reaction exerted by the table on the block,
(ii) the frictional force on the block, and
(iii) the coefficient of friction between the block and the table.

Answers:

1. $m = 116$ kg.

2. $F_T = 1.26 \times 10^3$ N

3. $F = -3.4 \times 10^3$ N.

4. (*a*) $F_G = 6.5 \times 10^2$ N. (*b*) $F_G = 1.1 \times 10^2$ N.

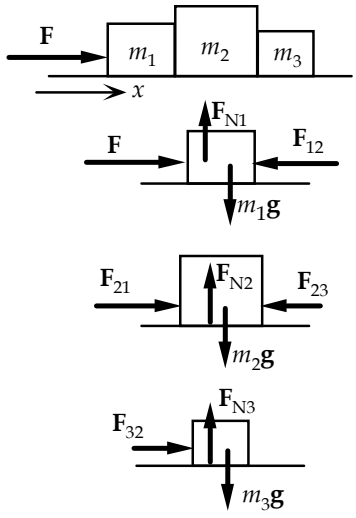
   (*c*) $F_G = 2.4 \times 10^2$ N. (*d*) $F_G = 0$.

5. (*a*) $F_G = 196$ N. $F_N = m2g = 196$ N.

   (*b*) $F_{N2} = 294$ N. $F_{N1} = 98.0$ N.

6. $F = 1.29 \times 10^3$ N.

7. (*a*) refer to diagram shown.



(*b*) $a = F/(m_1 + m_2 + m_3)$.

(c) $F_{net1} = m_1a = m_1F/(m_1 + m_2 + m_3)$; $F_{net2} = m_2a = m_2F/(m_1 + m_2 + m_3)$; $F_{net3} = m_3a = m_3F/(m_1 + m_2 + m_3)$.

(*d*) $F_{12} = F(m_2 + m_3)/(m_1 + m_2 + m_3)$. This is also F_{21} (Newton's third law).

$F_{net2} = F_{21} - F_{23} = m_2a$, which gives

$F_{23} = Fm_3/(m_1 + m_2 + m_3)$.

This is also F_{32} (Newton's third law).

(*e*) $a = 2.67$ m/s^2.

$F_{net1} = 32$ N. $F_{net2} == 32$ N. $F_{net3} = 32$ N.

$F_{21} = F_{12} = 64$ N. $F_{32} = F_{23} = 32$ N.

8. $F_{T1} = 22.6$ N. $F_{T2} = 20.9$ N. $a = 1.7$ m/s^2.

9. $F_T = 1.3 \times 10^4$ N.

10. $a = -2.5$ m/s^2 (down).

11. $F = \mu_k F_N = 1.0 \times 10^2$ N. If $\mu_k = 0$, there is no force required to maintain constant speed.

12. (*a*) $\mu_s = 0.82$. (*b*) $\mu_k = 0.74$.

13. $x = 4.1$ m.

14. (*a*) $a = 2.5$ m/s^2. (*b*) $F_{12} = 4.4 \times 10^2$ N.

15. 1.1 m/s^2

16. (a) 8.5N (b) 2.2N (c) 0.26