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EEC211 Tutorial Sheet

1. A fly lands on one wall of a room. The lower left-hand corner of the wall is selected as the origin of a two-dimensional Cartesian (x, y) coordinate system. If the fly is located at the point having coordinates (2.0, 1.0) m, (a) how far is it from the corner of the room? (b) What is its location in polar coordinates? (r, θ)

2. Vector **A** has a magnitude of 8.0 units and makes an angle of 45.0° with the positive x axis. Vector **B** also has a magnitude of 8.00 units and is directed along the negative x axis. Using graphical methods, find (a) the vector sum **A** + **B** and (b) the vector difference **A** - **B**.

3. A dog searching for a bone walks 3.50m south, then runs 8.20 m at an angle 30.0° north of east, and finally walks 15.0 m west. Find, the dog's resultant displacement vector using graphical techniques.

4. Given the vectors **A** = 2**i** + 6**j** and **B** = 3**i** - 2**j**, (a) draw the vector sum **C** = **A** + **B** and the vector difference **D** = **A** - **B**. (b) Calculate **C** and **D**, first in terms of unit vectors and then in terms of polar coordinates, with angles measured with respect to the $+x$ axis.

5. If the average velocity of an object is zero in some time interval, what can you say about the displacement of the object for that interval?

6. Two cars are moving in the same direction in parallel lanes along a highway. At some instant, the velocity of car A exceeds the velocity of car B. Does this mean that the acceleration of A is greater than that of B? Explain.

7. If an object's average velocity is nonzero over some time interval, does this mean that its instantaneous velocity is never zero during the interval? Explain your answer.

8. Is it possible for the velocity and the acceleration of an object to have opposite signs? If not, state a proof. If so, give an example of such a situation and sketch a velocity–time graph to prove your point.

9. A person walks first at a constant speed of 5 m/s along a straight line from point A to point B and then back along the line from B to A at a constant speed of 3 m/s. What is (a) her average speed over the entire trip? (b) her average velocity over the entire trip?

10. The position of a particle moving along the x axis varies in time according to the expression $x = 3t^2$, where x is in meters and t is in seconds. Evaluate its position (a) at $t = 3$s and (b) at 3s + Δt. (c) Evaluate the limit of $\Delta x/\Delta t$ as Δt approaches zero, to find the velocity at $t = 3$s.

11. An object moves along the x axis according to the equation $x(t) = (3t^2 - 2t + 3)$ m. Determine (a) the average speed between $t = 2$s and $t = 3$s, (b) the instantaneous speed at $t = 2$s and at $t = 3$s, (c) the average acceleration between $t = 2$s and $t = 3$s, and (d) the instantaneous acceleration at $t = 2$s and $t = 3$s.

12. A jet plane lands with a speed of 100 m/s and can accelerate at a maximum rate of -5 m/s^2 as it comes to rest. (a) From the instant the plane touches the runway, what is the minimum time interval needed before it can come to rest? (b) Can this plane land on a small tropical island airport where the runway is 0.8km long?

13. The driver of a car slams on the brakes when he sees a tree blocking the road. The car slows uniformly with an acceleration of -5.6 m/s^2 for 4.2s, making straight skid marks 62.4 m long ending at the tree. With what speed does the car then strike the tree?

14. An electron in a cathode ray tube (CRT) accelerates from 2 x 10^4 m/s to 6 x 10^6 m/s over 1.5cm. (a) How long does the electron take to travel this 1.5 cm? (b) What is its acceleration?

15. A ball starts from rest and accelerates at 0.5 m/s^2 while moving down an inclined plane 9m long. When it reaches the bottom, the ball rolls up another plane, where, after moving 15m, it comes to rest. (a) What is the speed of the ball at the bottom of the first plane? (b) How long does it take to roll down the first plane? (c) What is the acceleration along the second plane? (d) What is the ball's speed 8m along the second plane?

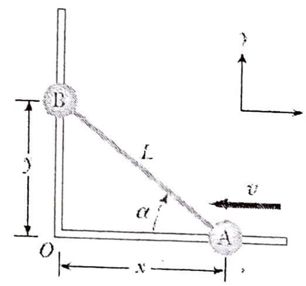
16. A ball is thrown directly downward, with an initial speed of 8 m/s, from a height of 30 m. After what time interval does the ball strike the ground?

17. A baseball is hit so that it travels straight upward after being struck by the bat. A fan observes that it takes 3s for the ball to reach its maximum height. Find (a) its initial velocity and (b) the height it reaches.

18. The height of a helicopter above the ground is given by $h = 3t^3$, where h is in meters and t is in seconds. After 2s, the helicopter releases a small mailbag. How long after its release does the mailbag reach the ground?

19. An inquisitive physics student and mountain climber climbs a 50m cliff that overhangs a calm pool of water. He throws two stones vertically downward, 1s apart, and observes that they cause a single splash. The first stone has an initial speed of 2m/s. (a) How long after release of the first stone do the two stones hit the water? (b) What initial velocity must the second stone have if they are to hit simultaneously? (c) What is the speed of each stone at the instant the two hit the water?

20. Two objects, A and B, are connected by a rigid rod that has a length L. The objects slide along perpendicular guide rails, as shown in Figure P19. If A slides to the left with a constant speed v, find the velocity of B when $\alpha = 60.0°$.



21. What is wrong with the statement "Because the car is at rest, there are no forces acting on it"? How would you correct this sentence?

22. A rubber ball is dropped onto the floor. What force causes the ball to bounce?

23. If the action and reaction forces are always equal in magnitude and opposite in direction to each other, then doesn't the net vector force on any object necessarily add up to zero? Explain your answer.

24. Describe a few examples in which the force of friction exerted on an object is in the direction of motion of the object.

25. A force F applied to an object of mass m_1 produces an acceleration of 3 m/s^2. The same force applied to a second object of mass m_2 produces an acceleration of 1 m/s^2. (a) What is the value of the ratio m_1/m_2? (b) If m_1 and m_2 are combined, find their acceleration under the action of the force F.

26. A 3-kg object undergoes an acceleration given by $\mathbf{a} = (2\mathbf{i} + 5\mathbf{j})$ m/s^2. Find the resultant force acting on it and the magnitude of the resultant force.

27. To model a spacecraft, a toy rocket engine is securely fastened to a large puck, which can glide with negligible friction over a horizontal surface, taken as the xy plane. The 4-kg puck has a velocity of $300\mathbf{i}$ m/s at one instant. Eight seconds later, its velocity is to be $(800\mathbf{i} + 10\mathbf{j})$ m/s. Assuming the rocket engine exerts a constant horizontal force, find (a) the components of the force and (b) its magnitude.

28. An electron of mass 9.11×10^{-31} kg has an initial speed of 3×10^5 m/s. It travels in a straight line, and its speed increases to 7×10^5 m/s in a distance of 5cm. Assuming its acceleration is constant, (a) determine the force exerted on the electron and (b) compare this force with the weight of the electron, which we neglected.

29. A 3-kg object is moving in a plane, with its x and y coordinates given by $x = 5t^2 - 1$ and $y = 3t^3 + 2$, where x and y are in meters and t is in seconds. Find the magnitude of the net force acting on this object at $t = 2$s.

30. A bag of cement of weight 325N hangs from three wires as suggested in Figure P29. Two of the wires make angles $\theta_1 = 60.0°$ and $\theta_2 = 25.0°$ with the horizontal. If the system is in equilibrium, find the tensions T_1, T_2, and T_3 in the wires.

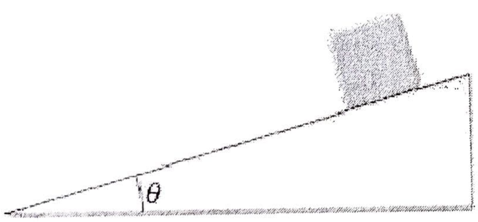


Fig P31

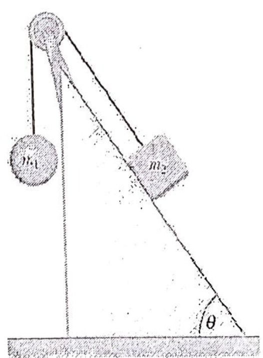


Fig P32

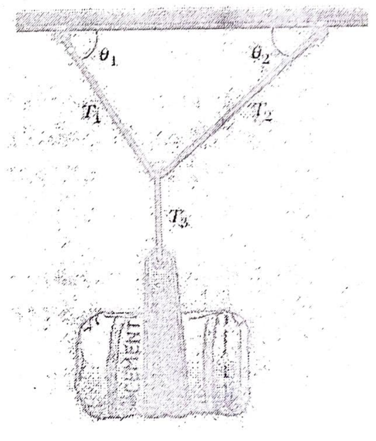


Fig P30

31. Draw a free-body diagram of a block which slides down a frictionless plane having an inclination of $\theta = 15.0°$ (Fig. P30). The block starts from rest at the top and the length of the incline is 2 m. Find (a) the acceleration of the block and (b) its speed when it reaches the bottom of the incline.

32. Two objects are connected by a light string that passes over a frictionless pulley, as in Figure P31. Draw free-body diagrams of both objects. If the incline is frictionless and if $m_1 = 2$kg, $m_2 = 6$kg, and $\theta = 55.0°$, find (a) the accelerations of the objects, (b) the tension in the string, and (c) the speed of each object 2s after being released from rest.

33. A 25-kg block is initially at rest on a horizontal surface. A horizontal force of 75N is required to set the block in motion. After it is in motion, a horizontal force of 60N is required to keep the block moving with constant speed. Find the coefficients of static and kinetic friction from this information.

34. A 3-kg block starts from rest at the top of a 30.0° incline and slides a distance of 2 m down the incline in 1.5s. Find (a) the magnitude of the acceleration of the block, (b) the coefficient of kinetic

friction between block and plane, (c) the friction force acting on the block, and (d) the speed of the block after it has slid 2 m.

35. Three objects are connected on the table as shown in Figure P34. The table is rough and has a coefficient of kinetic friction of 0.35. The objects have masses of 4-kg, 1-kg, and 2-kg, as shown, and the pulleys are frictionless. Draw free-body diagrams of each of the objects. (a) Determine the acceleration of each object and their directions. (b) Determine the tensions in the two cords.

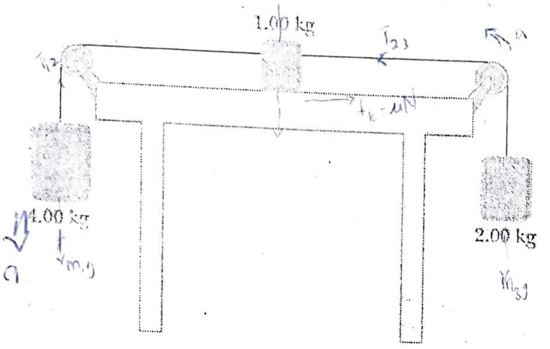


Fig P35

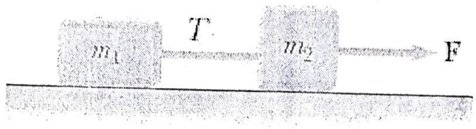


Fig P36

36. Two blocks connected by a rope of negligible mass are being dragged by a horizontal force **F** (Fig. P35). Suppose that $F = 68$N, $m_1 = 12$-kg, $m_2 = 18$-kg, and the coefficient of kinetic friction between each block and the surface is 0.1. (a) Draw a free-body diagram for each block. (b) Determine the tension T and the magnitude of the acceleration of the system.

37. A crate of weight F_g is pushed by a force **P** on a horizontal floor. (a) If the coefficient of static friction is μ_s and **P** is directed at angle θ below the horizontal, show that the minimum value of P that will move the crate is given by

$$P = \frac{\mu_s F_g \sec\theta}{1 - \mu_s \tan\theta}$$

(b) Find the minimum value of P that can produce motion when $\mu_s = 0.4$, $F_g = 100$ N, and $\theta = 0°$, 15.0°, 30.0°, 45.0°, and 60.0°.

38. Two blocks of mass 3.5-kg and 8-kg are connected by a massless string that passes over a frictionless pulley (Fig. P37). The inclines are frictionless. Find (a) the magnitude of the acceleration of each block and (b) the tension in the string.

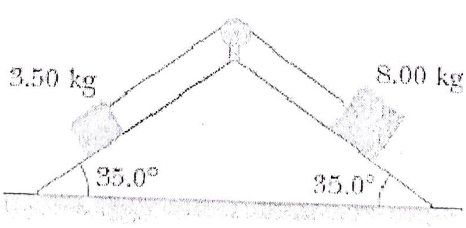


Fig P38