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PROGRAM STUDI SARJANA FISIKA
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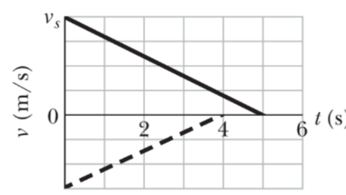
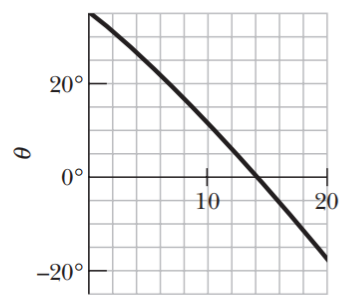
1st STUDENT ASSIGNMENT SHEET ELEMENTARY PHYSICS IA (FI-1101)
Semester 1 Year 2023-2024
TOPIC: KINEMATICS - DYNAMICS

For all problems air resistance can be ignored; use $g = 9{,}8\ \mathrm{m}/s^2$.

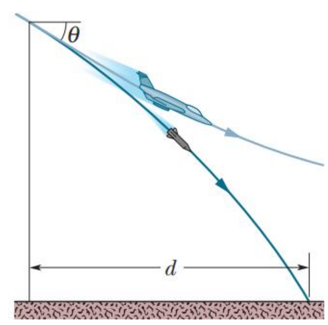
1. As two trains move along a track, their conductors suddenly notice that they are headed toward each other. The figure gives their velocities v as functions of time t as the conductors slow the trains. The figure's vertical scaling is set by $v_s = 40{,}0\ \mathrm{m/s}$. The slowing processes begin when the trains are 200 m apart. What is their separation when both trains have stopped?



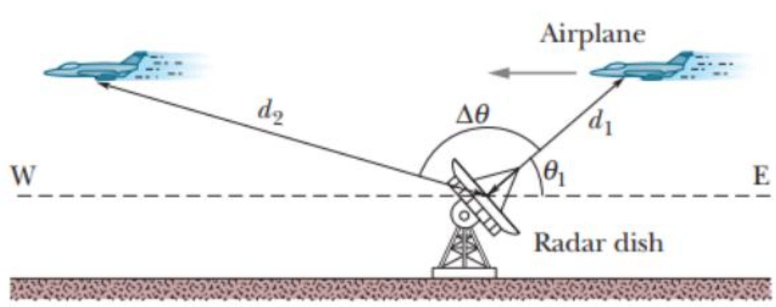
2. The position vector $\vec{r} = 5.00t\hat{\imath} + (et + ft^2)\hat{\jmath}$ locates a particle as a function of time t. Vector $\vec{r}$ is in meters, t is in seconds, and factors e and f are constants. The figure gives the angle θ of the particle's direction of travel as a function of t(θ is measured from the positive x direction). What are (a) e and (b) f, including units?



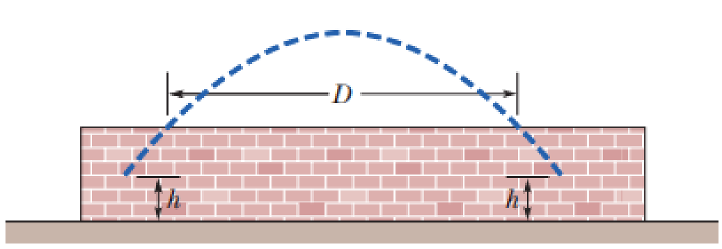
3. A certain airplane has a speed of 290.0 km/h and is diving at an angle of $\theta = 30.0°$ below the horizontal when the pilot releases a radar decoy (see figure). The horizontal distance between the release point and the point where the decoy strikes the ground is $d = 700\ m$.
   a. How long is the decoy in the air?
   b. How high was the release point?



4. In the following figure, a radar station detects an airplane approaching directly from the east. At first observation, the airplane is at distance $d_1 = 360\ m$ from the station and at angle $\theta = 40°$ above the horizon. The airplane is tracked through an angular change $\Delta\theta = 123°$ in the vertical east–west plane; its distance is then $d_2 = 790\ m$. Find:
   a. magnitude of the airplane's displacement during this period
   b. direction of the airplane's displacement during this period in vector notations.

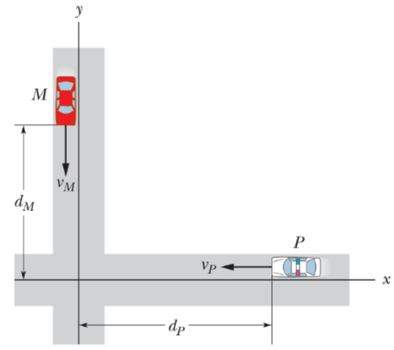


5. In the following figure, a baseball is hit at a height $h = 1.00\ m$ and then caught at the same height. It travels alongside a wall, moving up past the top of the wall $1.00\ s$ after it is hit and then down past the top of the wall $4.00\ s$ later, at distance $D = 50.0\ m$ farther along the wall. (a) What are the (b) magnitude and (c) angle (relative to the horizontal) of the ball's velocity just after being hit? (d)
   a. What horizontal distance is traveled by the ball from hit to catch?
   b. What is the magnitude of the ball's velocity just after being hit?
   c. What is the angle (relative to the horizontal) of the ball's velocity just after being hit?
   d. How high is the wall?



6. The fast French train known as the TGV (Train à Grande Vitesse) has a scheduled average speed of 216 km/h. (a) If the train goes around a curve at that speed and the magnitude of the acceleration experienced by the passengers is to be limited to 0.050g, what is the smallest radius of curvature for the track that can be tolerated? (b) At what speed must the train go around a curve with a 1.00 km radius to be at the acceleration limit?

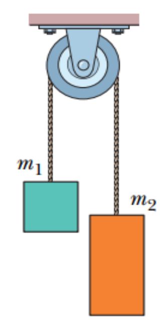
7. Two highways intersect as shown in the figure. At the instant shown, a police car P is at a distance $d_P = 800$ m from the intersection and moving at speed $v_P = 80$ km/h. Motorist M is at a distance $d_M = 600$ m from the intersection and moving at speed $v_M = 60$ km/h. (a) In unit-vector notation, what is the velocity of the motorist with respect to the police car? (b) For the instant shown in the figure, what is the angle between the velocity found in (a) and the line of sight between the two cars? (c) If the cars maintain their velocities, do the answers to (a) and (b) change as the cars move nearer the intersection?



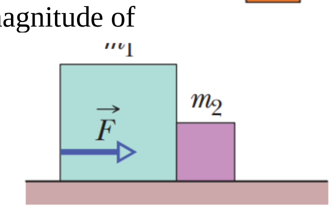
8. A 0.340 kg particle moves in an xy plane according to $x(t) = -15.00 + 2.00t - 4.00t^3$ and $y(t) = 25.00 + 7.00t - 9.00t^2$, with x and y in meters and t in seconds. At $t = 0.700$ s, what are (a) the magnitude and (b) the angle (relative to the positive direction of the x axis) of the net force on the particle, and (c) what is the angle of the particle's direction of travel.

9. A banked circular highway curve is designed for traffic moving at 60 km/jam. The radius of the curve is 200 m. Traffic is moving along the highway at 40 km/h on a rainy day. What is the minimum coefficient of friction between tires and road that will allow cars to take the turn without sliding off the road? (Assume the cars do not have negative lift.)

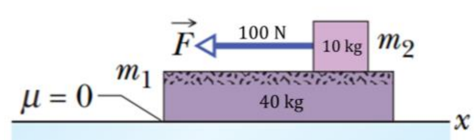
10. The next figure shows Atwood's machine, in which two containers are connected by a cord (of negligible mass) passing over a frictionless pulley (also of negligible mass). At time $t = 0$, container 1 has mass 1.30 kg and container 2 has mass 2.80 kg, but container 1 is losing mass (through a leak) at the constant rate of 0.200 kg/s. At what rate is the acceleration magnitude of the containers changing at (a) $t = 0$ and (b) $t = 3.00\ s$? (c) When does the acceleration reach its maximum value?



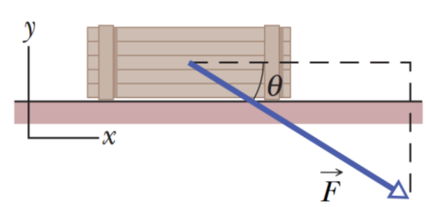
11. Two blocks are in contact on a frictionless table. A horizontal force is applied to the larger block, as shown in the figure. (a) If $m_1 = 2.3$ kg, $m_2 = 1.2$ kg, and $F = 3.2$ N, find the magnitude of the force between the two blocks. (b) If a force of the same magnitude F is applied to the smaller block but in the opposite direction, find the magnitude of the force between the blocks, (c) compare the two magnitudes in (a) and (b), explain the difference.



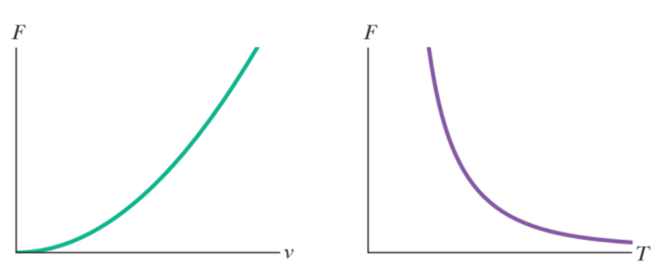
12. In the next figure, a slab of mass $m_1 = 40$ kg rests on a frictionless floor, and a block of mass m_2 10 kg rests on top of the slab. Between block and slab, the coefficient of static friction is 0.60, and the coefficient of kinetic friction is 0.40. A horizontal force of magnitude 100 N begins to pull directly on the block, as shown. In unit-vector notation, what are the resulting accelerations of (a) the block and (b) the slab?



13. In the figure, force $\vec{F}$ is applied to a crate of mass m on a floor where the coefficient of static friction between crate and floor is μ_s. Angle θ is initially 0° but is gradually increased so that the force vector rotates clockwise in the figure. During the rotation, the magnitude F of the force is continuously adjusted so that the crate is always on the verge of sliding. For $\mu_s = 0.70$, (a) plot the ratio F/mg versus θ and (b) determine the angle θ_{inf} at which the ratio approaches an infinite value. (c) Does lubricating the floor increase or decrease θ_{inf}, or is the value unchanged? (d) What is θ_{inf} for $\mu_s = 0.60$?



14. An 85.0 kg passenger is made to move along a circular path of radius $r = 3.50$ m in uniform circular motion. (a) Figure a is a plot of the required magnitude F of the net centripetal force for a range of possible values of the passenger's speed v. What is the plot's slope at $v = 8.30$ m/s? (b) Figure b is a plot of F for a range of possible values of T, the period of the motion. What is the plot's slope at T = 2.50 s?



15. A 1.34 kg ball is connected by means of two massless strings, each of length L = 1.70 m, to a vertical, rotating rod. The strings are tied to the rod with separation d = 1.70 m and are taut. The tension in the upper string is 35 N. What are the (a) tension in the lower string, (b) magnitude of the net force $\vec{F}_{net}$ on the ball, and (c) speed of the ball? (d) What is the direction of $\vec{F}_{net}$?