MCG 2108 - Fall 2015

DGD Week 1 (Monday 14th Sept and Thursday, 17th Sept)

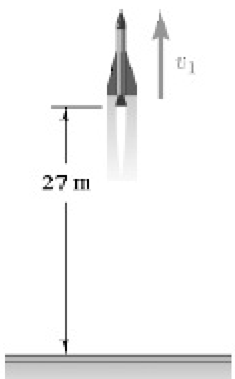
Chapter 11 (Part 1)

Pls Note:

Problem 11.51 will be solved on board by TA

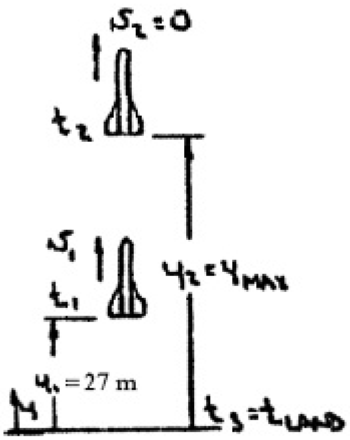
Remaining Problems will be assigned to students

PROBLEM 11.36



A group of students launches a model rocket in the vertical direction. Based on tracking data, they determine that the altitude of the rocket was 27 m at the end of the powered portion of the flight and that the rocket landed 16 s later. Knowing that the descent parachute failed to deploy so that the rocket fell freely to the ground after reaching its maximum altitude and assuming that $g = 9.81\ \text{m/s}^2$, determine (*a*) the speed v_1 of the rocket at the end of powered flight, (*b*) the maximum altitude reached by the rocket.

SOLUTION



(*a*) We have $y = y_1 + v_1 t + \frac{1}{2}at^2$

At t_{land}, $y = 0$

Then $0 = 27\ \text{m} + v_1(16\ \text{s}) + \frac{1}{2}(-9.81\ \text{m/s}^2)(16\ \text{s})^2$

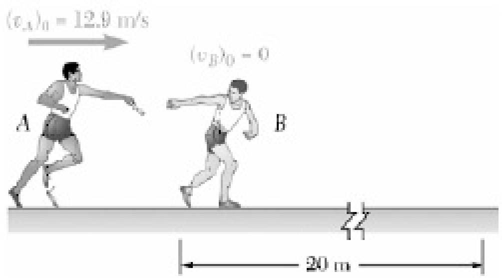
or $v_1 = 76.7925\ \text{m/s}$ $\qquad v_1 = 76.8\ \text{m/s}$ ◄

(*b*) We have $v^2 = v_1^2 + 2a(y - y_1)$

At $y = y_{\max}, \quad v = 0$

Then $0 = (76.7925\ \text{m/s})^2 + 2(-9.81\ \text{m/s}^2)(y_{\max} - 27)\text{m}$

or $y_{\max} = 327.57\ \text{m}$ $\qquad y_{\max} = 328\ \text{m}$ ◄



PROBLEM 11.39

As relay runner A enters the 20-m-long exchange zone with a speed of 12.9 m/s, he begins to slow down. He hands the baton to runner B 1.82 s later as they leave the exchange zone with the same velocity. Determine (a) the uniform acceleration of each of the runners, (b) when runner B should begin to run.

SOLUTION

(a) For runner A:

$$x_A = 0 + (v_A)_0 t + \frac{1}{2} a_A t^2$$

At $t = 1.82$ s:

$$20\text{ m} = (12.9\text{ m/s})(1.82\text{ s}) + \frac{1}{2} a_A (1.82\text{ s})^2$$

or

$$a_A = -2.10\text{ m/s}^2 \blacktriangleleft$$

Also

$$v_A = (v_A)_0 + a_A t$$

At $t = 1.82$ s:

$$(v_A)_{1.82} = (12.9\text{ m/s}) + (-2.10\text{ m/s}^2)(1.82\text{ s})$$
$$= 9.078\text{ m/s}$$

For runner B:

$$v_B^2 = 0 + 2a_B\left[x_B - 0\right]$$

When

$$x_B = 20\text{ m},\quad v_B = v_A:\quad (9.078\text{ m/s})^2 = 2a_B(20\text{ m})$$

or

$$a_B = 2.0603\text{ m/s}^2$$

$$a_B = 2.06\text{ m/s}^2 \blacktriangleleft$$

(b) For runner B:

$$v_B = 0 + a_B(t - t_B)$$

where t_B is the time at which he begins to run.

At $t = 1.82$ s:

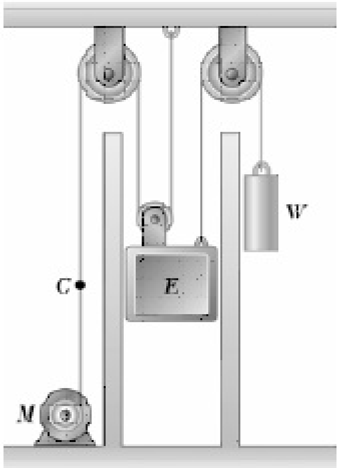
$$9.078\text{ m/s} = (2.0603\text{ m/s}^2)(1.82 - t_B)\text{s}$$

or

$$t_B = -2.59\text{ s}$$

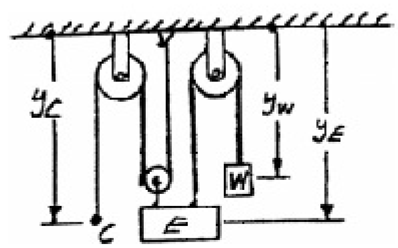
Runner B should start to run 2.59 s before A reaches the exchange zone. ◀

PROBLEM 11.47



The elevator shown in the figure moves downward with a constant velocity of 4 m/s. Determine (*a*) the velocity of the cable *C*, (*b*) the velocity of the counterweight *W*, (*c*) the relative velocity of the cable *C* with respect to the elevator, (*d*) the relative velocity of the counterweight *W* with respect to the elevator.

SOLUTION



Choose the positive direction downward.

(*a*) Velocity of cable *C*.

$$y_C + 2y_E = \text{constant}$$

$$v_C + 2v_E = 0$$

But, $v_E = 4$ m/s

or $v_C = -2v_E = -8$ m/s

$\mathbf{v}_C = 8.00 \text{ m/s} \uparrow$ ◀

(*b*) Velocity of counterweight *W*.

$$y_W + y_E = \text{constant}$$

$$v_W + v_E = 0 \quad v_W = -v_E = -4 \text{ m/s}$$

$\mathbf{v}_W = 4.00 \text{ m/s} \uparrow$ ◀

(*c*) Relative velocity of *C* with respect to *E*.

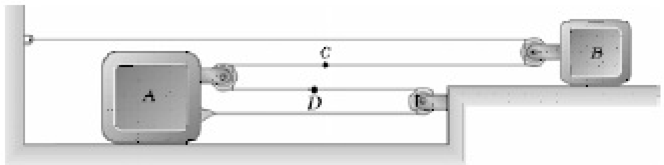
$$v_{C/E} = v_C - v_E = (-8 \text{ m/s}) - (+4 \text{ m/s}) = -12 \text{ m/s}$$

$\mathbf{v}_{C/E} = 12.00 \text{ m/s} \uparrow$ ◀

(*d*) Relative velocity of *W* with respect to *E*.

$$v_{W/E} = v_W - v_E = (-4 \text{ m/s}) - (4 \text{ m/s}) = -8 \text{ m/s}$$

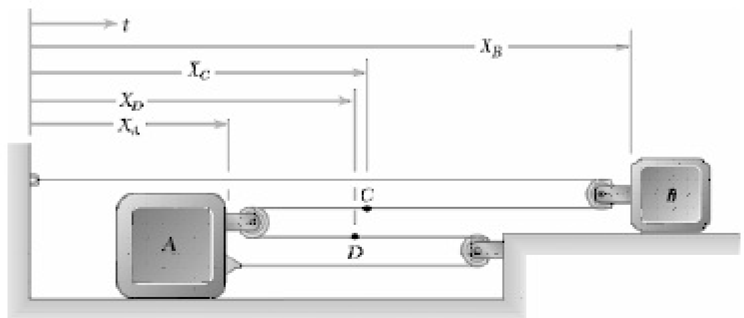
$\mathbf{v}_{W/E} = 8.00 \text{ m/s} \uparrow$ ◀



PROBLEM 11.51

Slider block B moves to the right with a constant velocity of 300 mm/s. Determine (*a*) the velocity of slider block A, (*b*) the velocity of portion C of the cable, (*c*) the velocity of portion D of the cable, (*d*) the relative velocity of portion C of the cable with respect to slider block A.

SOLUTION



From the diagram $\quad x_B + (x_B - x_A) - 2x_A = \text{constant}$

Then $\quad 2v_B - 3v_A = 0 \quad (1)$

and $\quad 2a_B - 3a_A = 0 \quad (2)$

Also, we have $\quad -x_D - x_A = \text{constant}$

Then $\quad v_D + v_A = 0 \quad (3)$

(*a*) Substituting into Eq. (1) $\quad 2(300 \text{ mm/s}) - 3v_A = 0$

or $\quad \mathbf{v}_A = 200 \text{ mm/s} \longrightarrow$ ◀

(*b*) From the diagram $\quad x_B + (x_B - x_C) = \text{constant}$

Then $\quad 2v_B - v_C = 0$

Substituting $\quad 2(300 \text{ mm/s}) - v_C = 0$

or $\quad \mathbf{v}_C = 600 \text{ mm/s} \longrightarrow$ ◀

PROBLEM 11.51 (Continued)

(*c*) From the diagram $(x_C - x_A) + (x_D - x_A) = \text{constant}$

Then $v_C - 2v_A + v_D = 0$

Substituting $600 \text{ mm/s} - 2(200 \text{ mm/s}) + v_D = 0$

or $\mathbf{v}_D = 200 \text{ mm/s} \longleftarrow$ ◀

(*d*) We have

$$v_{C/A} = v_C - v_A$$
$$= 600 \text{ mm/s} - 200 \text{ mm/s}$$

or $\mathbf{v}_{C/A} = 400 \text{ mm/s} \longrightarrow$ ◀