Ch 9 HW Assignment: Answers & HW Hints (Pt. 1)

Part 1: Center of Mass

Pg. 229-230 #2, 1, 3, 4, 6, 7, 9, 10, 15

Answers

2a. 1.07m

b. 1.33m

c. Toward m_3

1a. -1.5m

b. -1.43m

c. Towards m_3

3a. -0.45cm

b. -2.05cm

4a. 11cm (by symmetry)

b. -4.4cm

6a. 20cm (by symmetry)

b. 20cm (by symmetry)

c. 16cm

7a. -6.5cm (by symmetry)

b. 8.32cm

c. 1.4cm (by symmetry)

9. (-4i+4j)m

10. 6.19m

15. 53.1m

Ch 9 #9

Keep in mind that you're not looking at how the forces accelerate the individual particles, but instead at how the forces are accelerating the C.O.M. of the *entire system*. So calculate the acceleration (using i-hat, j-hat notation) of the whole system, due to those external forces. Then use kinematics in each direction to find the displacement of the center of mass of the whole system.

Ch 9 #15

The easiest way to think about this one is by calculating where the center of mass of the system ‘lands’. You can do this in a few different ways, all with old projectile ideas. But once you find this landing place of the C.O.M. you still have a little bit of thinking to do about where piece 2 must have landed, relative to piece 1, in order for the C.O.M. to land at the required position.

Ch 9 HW Assignment: Answers & HW Hints (Pt. 2)

Part 2: Linear Momentum

Pg. 231 #18-22

Answers

18. 4.9kgm/s

19a. 74,537J

b. 38,178kgm/s

c. 38.8^{o} S of E

20a. 30^{o}

b. -0.57j kgm/s

21a. 5.03kgm/s

b. 10.03kgm/s

22. 48.2^{o}

Ch 9 #18

If you know what momentum is, and you remember that momentum is a *vector* quantity, then this is actually an easy one. (The trick is that the two momentum values are in opposite directions, so be sure to make one of ‘em negative.)

Ch 9 #19

Part A is easy, since KE is a scalar quantity. But on part B, you must consider directions because momentum is a vector. It's definitely easiest if you start by thinking in i/j/k unit-vector notation, where you should be able to find the object's initial momentum and final momentum. Then subtract final minus initial to arrive at the vector-notation version of the momentum- change vector.

- continued on next slide -

Ch 9 #19 (cont.)

Lastly, use the Pythagorean theorem to find the magnitude of the p-change vector. On part C, just use $\tan^{-1}$ to find the direction of the p-change vector.

So your values should look like this…

$p_i = 0i + 23{,}919j \qquad p_f = 29{,}757i + 0j$

Those lead to $\Delta p = -29{,}757i + 23{,}919j$

Then finish 'er off with pyth them and $\tan^{-1}$.

Ch 9 #20

Part A should make sense from symmetry (and playing pool?), and part B should feel <u>very</u> similar to #19, except easier. Start by calculating initial and final momentum values (think of 'em as vector components) using unit-vector notation. Then subtract to find the change, and you're done!

Ch 9 #21

This one is again quite similar to #19 & 20. Start by finding the initial momentum, in unit-vector notation. Then find the easy final momentum vector, and subtract to find the change. You do need to finish by finding the magnitude of the change, which means a visit with our dear old friend Pythagoras.

Ch 9 #22

This one is actually very easy if you stop to think about what the graph is telling you. The projectile's initial momentum was angled, but by the time it hits its maximum height, all of its momentum should be in the x-direction. But since the x-direction momentum never changes, this x-direction value is the same as the x-component of the initial angled value. So if you know the entire initial vector, and you also know its x-component, you should have no trouble finding the angle of launch.

Ch 9 HW Assignment: Answers & HW Hints (Pt. 3)

Part 3: Collisions & Impulse

Pg. 231-233 #23, 26, 27, 29-31, 34-36, 38

Answers

23a. 67m/s
b. neg x-dir
c. 1200N
d. neg x-dir

26a. 1.11m
b. 4760Ns

27a. 42Ns
b. 2100N

29. 5N

30a. 30kgm/s
b. 37.5kgm/s
c. +6m/s

31a. 5.86Ns
b. 59.8^{o}
c. 2930N
d. 59.8^{o}

34a. 1Ns
b. 100N
c. 20N

35a. 9Ns
b. 3000N
c. 4500N
d. 20m/s

36a. (1.8j) Ns
b. (180j) N

38a. 7.18Ns
b. 16kgm/s

Ch 9 #26

On part A, where you're asked for the minimum depth of snow that can safely stop him, you just need to make a connection between the *time* it takes for him to come to a stop, and the *distance* it takes for him to come to a stop. The way to connect those two ideas is through a kinematic. The easiest one actually isn't on your formula sheet, though. It goes like this… $x = v_{avg}t = ((v+v_o)/2)t$.

Ch 9 #29

This one might feel a little different, since it deals with repeated collisions. But it works (and should make sense) to just think of it as an average force acting over the course of a minute, where the mass is the mass of 100 bullets.

Ch 9 #30

You'll obviously be dealing with impulse as the area under the curve on this one. Just make sure you remember that anytime the curve passes under the x-axis, you should find area above the curve and call the impulse negative.

Ch 9 #35

Part A and B aren’t too rough, if you look back at our calculus-based example from class. But part C is asking for the maximum force. If you think about it, you should realize that force will reach a max when dF/dt equals zero. So find the derivative of the F function, and set it equal to zero. When you find this time, plug it back into the original function to find the max force.

Ch 9 #38

Part A should make sense if you look back at our calculus-based example from class, being sure that you remember to evaluate the integral at t=1.25 <u>and</u> at t=0.5, and to subtract the two values to find the value of this definite integral. On part B, you need to start by finding the moment when the force equals zero, and then basically repeat what you did on part A.

Ch 9 HW Assignment: Answers & HW Hints (Pt. 4)

Part 4: Conservation of Momentum

Pg. 233-234 #40, 42, 45, 47, 49, 50, 54, 56, 58 (Skip #55)

Answers

40. 4365.6km/h
42. 3.50m/s
45. 14.14m/s @ 45° CCW from +x-axis
47a. (1000i-166.7j)m/s
    b. 3,228,507J
49. 308.3m/s
50a. 1.81m/s
    b. 4.96m/s
54. 7.3cm
56. 2.64m
58. 32.7cm

Ch 9 #40

Don't worry that you don't know the actual mass value- just use the 4M and M stuff they told you, and everything will cancel when you need it to.

For the final speed of the rocket, keep in mind that it says the speed is 82km/h backwards *relative to the command module.* Since you want to actually work the problem relative to a stationary observer (which is how speeds are typically stated), you need to call the rocket's final speed... $v_{module,final} - 82$

Ch 9 #47

For part B, just calculate the object's KE before the explosion, and then also calculate the total KE of the three objects after the explosion. (This does require you to take your part A answer and write it as a speed magnitude rather than in unit-vector notation.) Then subtract initial from final to calculate the ΔKE.

Ch 9 #50

For part B, you need to think about speed of the COM just like you used to calculate the position of the COM. In fact, you can even use the same exact formula you use for position, but just switch it to speed…

$$v_{com} = (1/M)\Sigma(m_i v_i)$$

It's also worth it to mention that you can either calculate v_{com} before or after the collision. It doesn't matter because the v_{com} must stay constant for a closed, isolated system.

Ch 9 #55

Skip this one.

Ch 9 HW Assignment: Answers & HW Hints (Pt. 5)

Part 5: Elastic Collisions

Pg. 235-236 #61, 63, 64, 66, 68

Answers

61a. 98.7g

b. 1.86m/s

c. 0.93m/s

63a. 1.2kg

b. 2.5m/s

64a. 29.8cm

b. 3.33m

66a. 2.47m/s

b. 1.23m/s

68a. 2.22m

b. 0.56m

Ch 9 #61 & 63

These are just like part B of #50, so go back and look at that HW hint.

Ch 9 HW Assignment: Answers & HW Hints (Pt. 6)

Part 6: More p-Conservation and E-Conservation Problems

Pg. 239-249 #123, 125, 126

Answers

123. 29.25J

125. 5.04×10^{6}N

126a. 4.4m/s

b. 38.4J

Ch 9 #125

You should be able to figure out that the problem begins with energy-conservation for the falling block. But then realize that a momentary collision occurs, imparting momentum to the pile (which is sort of like a spike?), which means you need to use conservation of momentum. Lastly, the pile and block come to a stop because of a net force acting on them. You can find this force in several ways, but the best review would be to use impulse and momentum ideas (after you use $x = v_{avg}t = ((v+v_o)/2)t$ to find time).

Ch 9 #126

Part A should be pretty straightforward, but part B could trick you a little bit. The main 'trick' is that you're told the k-value of the spring, which you don't need. Instead, you can actually think about energy-stuff from the perspective of the collision. Think like this… "How much energy does the system have before the collision? And how much afterward? And where the heck did those Joules of energy go, since there's no friction? Oh yeah, that energy was probably stored in the form of spring potential energy."