Sample Exam One Solutions

MC1) If up is positive, then the downward velocity is negative. This eliminates choices C) and D). If an object moving in one dimension is slowing, then its acceleration and velocity are in opposite directions, and so the acceleration is positive.

A)

MC2) (2) is false, since the two velocity curves never touch. This eliminate B), D), and E). The acceleration is given by the slopes of the lines, and there is in fact a point when the slope of the A curve matched the slope of the B line, about one third of the way along the t axis, so (3) is true. If (1) were true, there would be no correct choice, so (1) is presumably false; indeed, the displacements are given by the areas under each curve, and the area under A's curve is always larger than that under B's curve.

C)

MC3) $\vec{B}$-$\vec{A}$ is the same as $\vec{B}$ + (-$\vec{A}$). Use the 'tip to tail' method.

D)

MC 4) The point here is, do you understand that the acceleration of an object moving under the influence of only gravity near the earth's surface is 10 m/s^2 down?

B)

MC5) This is a more standard type of problem.

$$R = \frac{v_o^2 \sin(2\theta_o)}{|a_g|} \quad \rightarrow \quad \sin(2\theta_o) = \frac{R|a_g|}{v_o^2} = \frac{10{,}000(10)}{400^2} = 0.625$$

$$2\theta_o = \arcsin(0.625) = 38.7^o$$

$$\theta_o = \frac{38.7^o}{2} = 19.3^o \quad \text{and also this angle's complement } 90^o - 19.3^o = 70.7^o \ .$$

B)

PROBLEM I

The idea is to combine the three relationships in such a way as to eliminate v-final and re-arrange into the form of kinematic equation 3.

$$v_{AVE} = \frac{v + v_i}{2} = \frac{x - x_i}{t}$$

Re-arrange the other equation into kinematic equation 1 and substitute for v:

$$v = v_i + at \quad .$$

$$\frac{(v_i + at) + v_i}{2} = \frac{x - x_i}{t}$$

$$v_i + \frac{at}{2} = \frac{x - x_i}{t}$$

$$v_i t + \frac{at^2}{2} = x - x_i$$

$$x = x_i + v_i t + \frac{at^2}{2}$$

PROBLEM II

Find the components of A, B, and C, find the components of D, and recompose those into D's magnitude and direction angle.

$$A_x = A\cos\theta_A = 6\cos(-75^o) = 1.553$$

$$B_x = B\cos\theta_B = 5\cos(45^o) = 3.536$$

$$C_x = C\cos\theta_C = 8\cos(-135^o) = -5.657$$

$$A_y = A\sin\theta_A = 6\sin(-75^o) = -5.800$$

$$B_y = B\sin\theta_B = 5\sin(45^o) = 3.536$$

$$C_y = C\sin\theta_C = 8\sin(-135^o) = -5.657$$

To find the components of D, do with each set what you're asked to do with the vectors:

$$D_x = A_x + B_x - C_x = 1.553 + 3.536 - (-5.657) = 10.746$$

$$D_y = A_y + B_y - C_y = -5.800 + 3.536 - (-5.657) = 3.393$$

Then,

$$D = \sqrt{D_x^2 + D_y^2} = \sqrt{(3.393)^2 + (10.746)^2} = 11.269 \text{ m}$$

Don't forget the units.

$$\theta_D = \arctan\left(\frac{D_y}{D_x}\right) = \arctan\left(\frac{3.393}{10.746}\right) = 17.5^o$$

However, we must check the quadrant; seeing that the x-component of D is positive, we confirm that this is the correct angle.

PROBLEM III

The quickest way to do this is to form a proportion. The 770 km is the same fraction of the circumference as the 7 degrees is of 360 degrees.

$$\frac{7}{360} = \frac{770}{2\pi R} \quad \rightarrow \quad R = \frac{770(360)}{2\pi 7} = 6305 \text{ km}$$

PROBLEM IIII

This is a straight-forward kinematics problem. Let's make up be positive and put the origin at the top of the building.

Make an inventory:

x_i = 0 m
x_f = - 40 m
v_i = - 9 m/s
v_f = ? ←
a = - 10 m/s^2
t = ? ←

We'll try KEq 4 to find v_f:

$$v^2 = v_i^2 + 2a(x - x_i)$$

$$v = \sqrt{v_i^2 + 2a(x - x_i)} = \sqrt{(-9)^2 + 2(-10)(-40 - 0)} = \pm 29.7 \text{ m/s}$$

Since the ball is moving downward and downward is negative, the answer is – 29.7 m/s.

Since we now know v_f, we can use KEq 1 to find the time:

$$v = v_i + at \quad \rightarrow \quad t = \frac{v - v_i}{a} = \frac{-29.7 - (-9)}{-10} = 2.07 \text{ seconds}$$