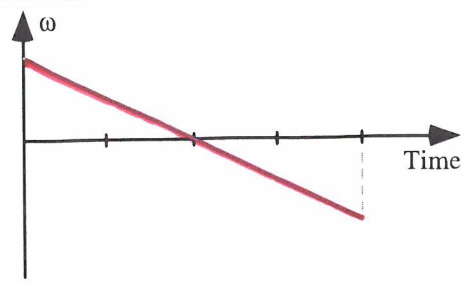
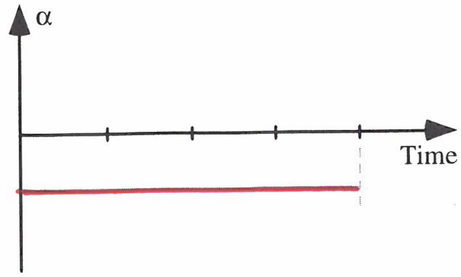
# AP Physics . Tipper #1-Unit 7 - KEY

**#1**

*Answer:*

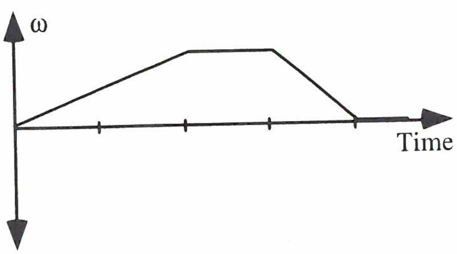


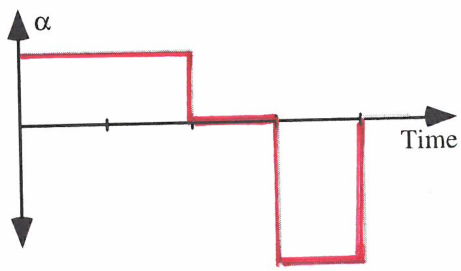




*The tension in the string resulting from the weight of the hanging block produces a constant torque on the pulley. So the pulley will rotate counterclockwise but slow down to stop at an instant, and then start rotating clockwise at an increasing rate. If we take the initial angular velocity as positive, then the angular acceleration has to be constant and negative.*

**#2**

*Answer: The slope of the line in the angular velocity graph tell us the angular acceleration. The first segment has a positive slope for two time units, then a zero slope for one time unit, a negative slope for one time unit, and finally a zero slope at zero velocity. The positive slope has a smaller magnitude than the negative slope, so the acceleration-time graph should look like the following:*

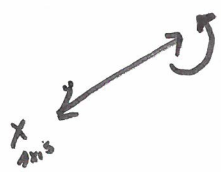



**#3**

$I = mr^2$

$I_{Total} = I_1 + I_2$




∴ can ignore All masses along X-Axis

· All mass are same distance Apart

· Too Rank Inertia, RANK Total mass

$I = mr^2$ Allsame

= Along Z & y Axis

| A | B | C | D |
|---|---|---|---|
| 4 white-Al | 2 Brass | 2 Brass | 4 Brass |
| | 2 Al | 2 Al | |

D > B = C > A

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#4 *Answer: C > A > B.*

*Based on the distribution of mass. Mass farther from axis contributes more to the moment of inertia than mass closer to the axis. For the circular ring, all of the mass is at a distance R from the axis of rotation; and for the square loop almost all of the mass is at a distance that is greater than R. All of the mass of the disc is at a distance R or less.*

#5 Radius = ? $V = \omega R$ $R = \frac{V}{\omega}$

| A | B | C | D | E | F |
|---|---|---|---|---|---|
| $R = \frac{30}{10}$ | $R = \frac{50}{10}$ | $R = \frac{40}{10}$ | $R = \frac{50}{12.5}$ | $R = \frac{60}{20}$ | $R = \frac{60}{15}$ |
| $= 3$ | $= 5$ | $= 4$ | $= 4$ | $R = 3$ | $= 4$ |

B > C = D = F > A = E

#6 *Answer: F > B > E > C > D > A.*

*In order for the rods to be held stationary the clockwise torques must balance the counter-clockwise torques. All of the forces that act on the rods are vertical forces, so we can take the distances as the number of meters between each force and the pivot. For cases C and E the force applied to the rod has to be equal to the weight of the mass. The applied force for cases D and A are less than the weight of the mass since the mass has a shorter lever arm and thus produces a smaller torque. Cases F and B need the largest applied force since that force acts with a short lever arm and the hanging masses have large lever arms.*

A

$F_1R_1 = F_2R_2$

$F_2 = \frac{F_1R_1}{R_2}$

$= \frac{100(1)}{3}$

$= 33.3$ kg

B

$F_2 = \frac{100(4)}{1}$

$F_2 = 400$ kg

C

$F_2 = \frac{100(2)}{2}$

$F_2 = 100$

D

$F_1 = \frac{200(1)}{3}$

$F_2 = 66.6$

e

$F_2 = \frac{200(2)}{2}$

$F_2 = 200$

F:

$F_2 = \frac{200(3)}{1}$

$F_2 = 600$

F > B > E > C > D > A

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*Answer: B = C > A > D.*

#7 *Since all of the masses are the same a large translational speed corresponds to a large translational kinetic energy. At the bottom of the ramp all of the objects have converted all of their initial potential energy into kinetic energy. However the spheres will have converted some of the potential energy into rotational kinetic energy as well as translational kinetic energy, whereas all of the initial potential energy of the blocks will have been converted into translational kinetic energy. Since the height of the objects initially is all the same, all of the initial energies are the same. The shape of the ramp does not matter. Since a hollow sphere has agreater moment of inertia than a solid sphere, the hollow spheres will have a greater fraction of their energy as rotational energy when they are rolling without slipping.*

#8 *Answer: All the same.*

*None of the objects lose energy as they travel, so they will all have the same potential energy on the other side. All objects will come to rest on the other side at a height of 2 meters.*

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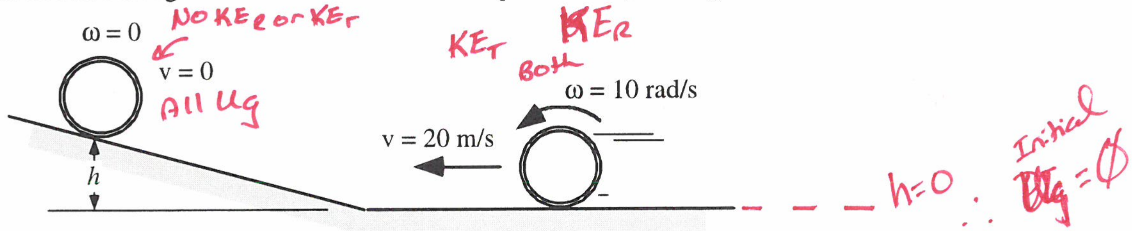
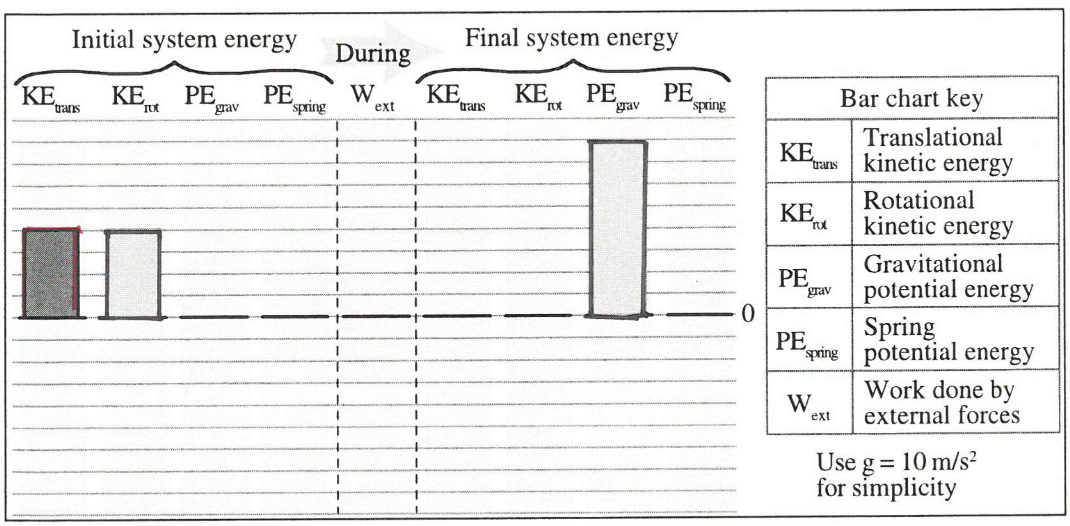
#9

## B6-BCT27: Hoop Rolling up a Ramp—Rotational Energy Bar Chart

A thin hoop or ring with a radius of 2 m is moving so that its center of mass is initially moving at 20 m/s while also rolling without slipping at 10 rad/s along a horizontal surface. It rolls up an incline, coming to rest as shown.




**Complete the qualitative energy bar chart below for the earth-hoop system for the time between when the hoop is rolling on the horizontal surface and when it has rolled up the ramp and is momentarily at rest.** Put the zero point for the gravitational potential energy at the height of the center of the hoop when it is rolling on the horizontal surface.




**Explain your reasoning.**

*Answer: Since the disk is initially at the zero gravitational potential energy height, there is no initial potential energy. The disk is translating (its center of mass is moving) and rotating, so there are initial kinetic energies of translation and rotation. For a thin ring rolling without slipping, $I = mr^2$ and $\omega = v/r$, so $KE_{rot} = (0.5)I\omega^2 = (0.5)(mr^2)(v/r)^2 = (0.5)mv^2$. The initial rotational kinetic energy is therefore equal to the initial translational kinetic energy. In the final state, the hoop is at rest (momentarily) on the incline, so it has neither rotational nor translational kinetic energies. All of the initial system energy has been converted into gravitational potential energy.*

#10

*Answer: Greater in case A.*

*The person holding the stick has to provide a torque to balance that exerted by the hanging masses. The torque due to the hanging mass is the weight of the mass times the perpendicular distance between the hand and the point on the stick where the mass is attached. In A the larger mass is farther from the hand.*