AP Physics – Unit 7 MC Review – Rotation
Wkst MC Review – Unit 7 – KEY

KEY

1. ANS: C
   Just as the tension in a rope is greatest at the bottom of a vertical circle, the force needed to maintain circular motion in any vertical circle is greatest at the bottom. The applied force must balance the weight of the object and additionally provide the necessary centripetal force.

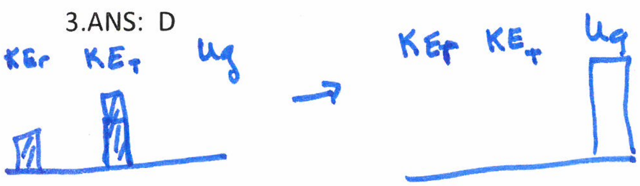
DIF: Easy TOP: Rotation MSC: NOT: Based on C 1993 #12

2. ANS: D

$$\Sigma F_{\parallel} = F_{adhesion} - mg = F_c$$
$$F_c = m\omega^2 r$$
$$F_{Adh} - mg = m\omega^2 r$$
$$F_{Adh} = m\omega^2 r + mg$$

DIF: Medium TOP: Rotation MSC: NOT: Based on C 1993 #13

3.ANS: D



$$K_T = \frac{1}{5}mv^2 + \frac{1}{2}mv^2$$
$$K_T = \frac{7}{10}mv^2$$

$$U_g = mgh_{max}$$

$$K_T = K_r + KE_T$$
$$= \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2$$
$$= \frac{1}{2}\left(\frac{2}{5}MR^2\right)\left(\frac{v}{R}\right)^2 + \frac{1}{2}mv^2$$

$$K_T = U_g$$
$$\frac{7}{10}\cancel{m}v^2 = \cancel{m}gh_{max}$$
$$h_{max} = \frac{7v^2}{10g}$$

DIF:Hard TOP: Rotation MSC: NOT: Based on C 1998 #6

4 ANS: D

$$\Sigma \tau = 0$$
$$(-6kg)gx + 8kg\,g(70cm - x) = 0$$
$$g = 10\ m/s$$
$$x = 40cm$$

$-(6 \text{ kg})gx + (8 \text{ kg})(g)(70 \text{ cm} - x) = 0$
Collect like terms and use 10 m/s2 for g and you get x = 40 cm, which is at point D. DIF: Easy TOP: Rotation MSC: 77% answered correctly

5.ANS: A

Because angular momentum is conserved, if the rear wheel spins faster in a clockwise direction then the rest of the motorcycle would have to rotate counterclockwise. Thus, the front end would rotate upward.

DIF: Medium TOP: Rotation MSC: NOT: Based on C 1998 #

6 ANS: C

This is a torque problem. If the pole is not to rotate, the clockwise torque must equal the counterclockwise torque. The definition of torque is distance multiplied by force multiplied by the sine of the angle between the force and the radius vectors. (The radius is drawn from the pivot point to the point where the force is applied.)

$$\tau_{clockwise} = (5\,kg)(g)\frac{L}{2}\sin 90^\circ$$

$$= \frac{5gL}{2}$$

$$\tau_{ccw} = (3.5\,kg)(g)\left(\frac{L}{2}\sin 90^\circ\right) + mg\frac{L}{4}\sin 90^\circ$$

$$= \frac{3.5gL}{2} + \frac{mgL}{4}$$

$$\tau_{cw} = \tau_{ccw}$$

$$\frac{5gL}{2} = \frac{3.5gL}{2} + \frac{mgL}{4}$$

$$\frac{10gL}{4} = \frac{7gL}{4} + \frac{mgL}{4}$$

7. ANS: B

No external torques are applied, so angular momentum is conserved. Walking to the outside edge causes the rotational inertia to increase, thus slowing the angular speed.

Because the kinetic energy is a function of the square of the angular speed, it will also decrease as the angular speed decreases. Work is done on the child by friction on the feet to walk outward.

DIF: Medium TOP: Rotation MSC: NOT: Based on C 2009 # 33

8 ANS: A

Without friction, there is no torque to cause the sphere to rotate so that it slides down the incline. This means the potential energy is tranformed into translational kinetic energy only.

$$U_g = K_T$$
$$mgh = \frac{1}{2}mv^2$$
$$v = \sqrt{2gh}$$

DIF: Medium TOP: Rotation MSC: NOT: Based on C 1998 #5

9 Ans: D

$$U_g = K_T + K_r$$
$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$
$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\left(\frac{v}{r}\right)^2$$
$$2mgh = \left(M + \frac{I}{r^2}\right)(v^2)$$

I

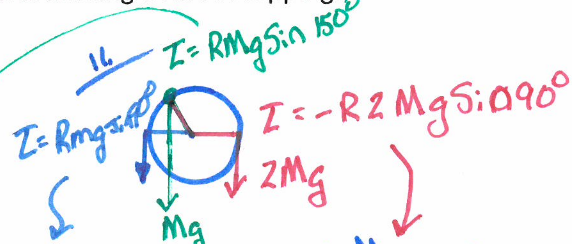
$$v^2 = \frac{2mgh}{\left(M + \frac{I}{r^2}\right)} \quad \left(\frac{r^2}{r^2}\right)$$
$$= \frac{2mghr^2}{I + Mr^2}$$

10. ANS: B

Both wheels have the same linear speed at their outside edges because both wheels are being rotated by the same belt that is moving without slipping.

v 1 = v 2

ω1 R1 = ω2 R2



CCW +

11. Answer C

$$\Sigma\tau = 0$$
$$RMg\sin 150^\circ + Rmg\sin 90^\circ - R2Mg\sin 90 = 0$$
$$0.5M + m - 2M = 0$$
$$m = 1.5M$$

12. ANS: A, B

Rotational inertia depends on the choice of axis of rotation, R.

12. A,B

Rotational inertia is proportional to the object's mass, M, regardless of the choice of axis of rotation. The units of rotational inertia are kg·m2.
A solid sphere of mass M and radius R has a rotational inertia of

$$I = \frac{2}{5} MR2$$

about a central axis. If the rotational axis is moved out to the edge of the sphere such that the axis is tangent to the sphere, then the rotational inertia would be

$$I = I_{cm} + MR^2$$

$$I = \frac{2}{5} MR^2 + MR^2$$

$$I = \frac{7}{5} MR^2$$

13. ANS: C, D
Because it is a perfectly inelastic (sticking) collision, kinetic energy is not conserved. As there are no external forces or torques, both linear and angular momentum are conserved.