College Physics

Phys 2010

Exam 2

Fall Semester 2008

Notes

- You may use a calculator
- This test is closed book and closed notes.

NAME: Key

Part 1: Multiple-Choice Questions

1. A CD has a diameter of 12.0 cm. If the CD starts from rest and has a constant angular acceleration of 2.0 rad/s^2, then the angular velocity of the CD after 3.0 sec is:
   A. 12 rad/s.
   B. 10 rad/s.
   C. 9.0 rad/s.
   D. 8.0 rad/s.
   (E.) 6.0 rad/s.

$\omega_i = 0$, $\alpha = 2$ rad/s^2, $\Delta t = 3$ s, $\omega_f = ?$

$\omega_f = \omega_i + \alpha \Delta t = (2)(3) = 6$ rad/s

2. A 2000 kg car is traveling on a banked curved icy road. The road is banked at an angle of 12.0 degrees and has a radius of curvature of 500 m. The velocity of the car necessary to travel on the icy road without sliding is:
   (A.) 32.3 m/s.
   B. 40.5 m/s.
   C. 42.8 m/s.
   D. 49.5 m/s.
   E. 50.2 m/s.

$V = \sqrt{rg\tan\theta} = \sqrt{(500)(9.8)\tan 12^\circ}$

$V = 32.3$ m/s

3. A 5,000 kg satellite is orbiting the earth in a circular path. The height of the satellite above the surface of the earth is 800 km. The velocity of the satellite is, ($M_e = 5.98 \times 10^{24}$ kg, $R_e = 6.37 \times 10^6$ m, $G = 6.67 \times 10^{-11}$ N•m^2/kg^2):
   (A.) 7,460 m/s.
   B. 6,830 m/s.
   C. 6,430 m/s.
   D. 5,950 m/s.
   E. 5,350 m/s.

$V = \sqrt{\frac{GM}{r}} = \sqrt{\frac{6.67\times10^{-11} \times 6\times10^{24}}{(6370+800)\times1000}} = 7458$ m/s

4. A CD with a diameter of 12.0 cm is rotating at 5.00 rad/s slows to a stop in 12.0 seconds with a constant angular deceleration. What is the magnitude of the angular acceleration and tangential acceleration of a point on the edge of the CD?
   A. 0.42 rad/s^2, 0.05 m/s^2
   B. 2.4 rad/s^2, 0.29 m/s^2
   C. 2.4 rad/s^2, 0.025 m/s^2
   (D.) 0.42 rad/s^2, 0.025 m/s^2
   E. 0.3 rad/s^2, 1.8 m/s^2

$\omega_i = 5$ rad/s $\omega_f = 0$

$\omega_f = \omega_i + \alpha \Delta t$

$0 = \omega_i + \alpha \Delta t \rightarrow \alpha = \frac{-5}{12} = -0.42$ rad/s^2

5. Padded dashboards in automobiles are safer because
   a. Momentum change is less
   b. The impulse is less
   c. Energy is less
   (d.) Impact time is greater

$a = r\alpha$

$= (0.06)(0.42)$

$= 0.025$ m/s^2

6. A baseball player grabs a 1-kg ball, which is moving horizontally at a speed of 20 m/s. The ball is brought to a rest in a time of 0.4 s. The force that the ball applies to the player's glove is

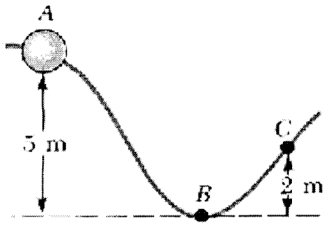
a. 50 N
b. 20 N
c. 9.8 N
d. 8 N

$$F = \frac{\Delta P}{\Delta t} = \frac{(1)(20)}{0.4}$$

$$= 50\ N$$

Part 2: Show all your work!

1. A 0.5-kg bead slides on a curved wire, starting from rest at point A and it comes to rest at point C. The segment from A to B is frictionless, and the segment from B to C is a rough section.



(a) Find the speed of the bead at B?

$K_A + U_A = K_B + U_B$

$0 \quad \downarrow \quad 0$

$(0.5)(9.8)(5) = \frac{1}{2}(0.5)(v_B^2)$

$v_B = \sqrt{2 \times 9.8 \times 5} = \sqrt{98} = \boxed{9.9 \text{ m/s}}$

(b) Find the total work done by friction in going from B to C.

$K_B + U_B + W_{nc} = K_C + U_C$

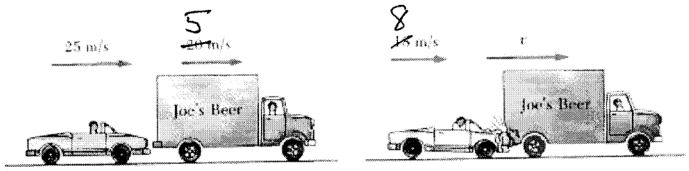
$0 \qquad\qquad 0$

$\frac{1}{2}(0.5)(9.9)^2 + W_{nc} = (0.5)(9.8)(2)$

$24.5 \qquad\qquad 9.8$

$W_{nc} = 9.8 - 24.5 = \boxed{-14.7 \text{ J}}$

2. A 1000-kg car traveling with a speed of 25 m/s in an easterly direction crashes into the rear end of a 12000-kg truck moving in the same direction at 5 m/s. The car and the truck do NOT couple to each other after the collision. The velocity of the car right after the collision is 8 m/s to the east. (a) What is the velocity of truck right after the collision? (b) How much mechanical energy is lost in the collision? Express your answer in percentage energy lost.



Before After

a) $P_i = (1000 \times 25) + (12000 \times 5) = 85000$ kg.m/s

$P_f = (1000 \times 8) + 12000 \times V = 8000 + 12000V$

$P_i = P_f \Rightarrow 85000 = 8000 + 12000V \rightarrow V = \frac{85-8}{12}$

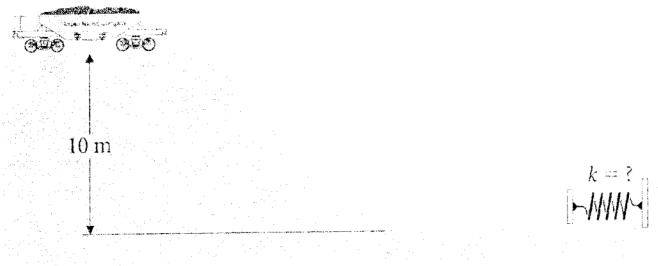
$\boxed{V = 6.4 \text{ m/s}}$

b) $K_i = \frac{1}{2}(1000)(25)^2 + \frac{1}{2}(12000)(5)^2 = 462500$ J

$K_f = \frac{1}{2}(1000)(8)^2 + \frac{1}{2}(12000)(6.4)^2 = 277760$ J

$\Delta K = \boxed{184740 \text{ J}}$ or $\frac{\Delta K}{K_i} = 0.4 = \boxed{40\%}$

Ore cars with total mass of 100 kg start from rest and roll without friction down the track to an unloading area 10 m below. They are stopped by a spring bumper and held with a clamp while they are unloaded.



a) What spring constant is needed if the bumper compresses by 2 m when stopping an ore car?

$$K_i + U_i = K_f + U_f + U_{elastic}$$

$$(100)(9.8)(10) = \frac{1}{2} k (2)^2$$

$$k = \frac{9800}{2} = \boxed{4900 \text{ N/m}}$$

b) After the car is unloaded its mass is reduced to 10 kg and the clamp is released. What is the speed of the empty car as it returns to the top of the track?

$$\cancel{K_i}^{0} + \cancel{U_i}^{0} + U_{elastic} = K_f + U_f$$

$$\frac{1}{2}(4900)(2)^2 = K_f + (10)(9.8)(10)$$

$$\Rightarrow K_f = 8820 \text{ J} = \frac{1}{2}(10) v_f^2 \Rightarrow$$

$$\boxed{v_f = 42 \text{ m/s}}$$