Name (printed)________________________ Name (signature)__Key________

Section __________ Instructor ________________________

Exam 2 Fall 2023 – Chs. 6-8 in Young & Adams 11e

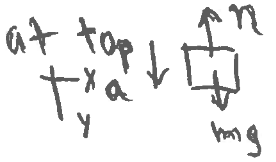
Multiple choice questions. Circle the correct answer. No partial credit. Each question is worth 5 points.

1. A person with weight *w* sits on a circular Ferris wheel going around at a constant speed. At which point along the path is the normal force acting on the person the greatest in magnitude, or is it the same at all points?

C

(a) Point 1 (top)
(b) Point 2 (right)
[✓ (c) Point 3 (bottom)]
(d) Point 4 (left)
(e) It is the same at all points

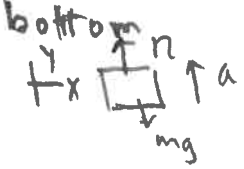
at top



$mg - n = ma$

$n = mg - ma$

at bottom



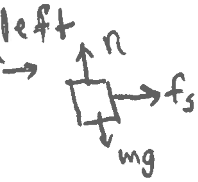
$n - mg = ma$

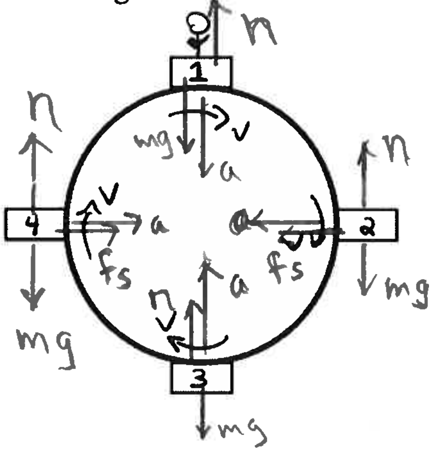
$n = mg + ma$

at right or left

$n = mg$

$f_s = ma$

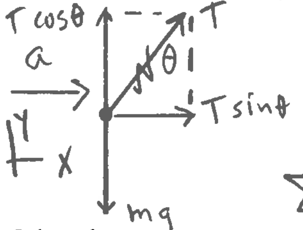




2. A 0.1 kg stone connected to a string travels in a uniform, horizontal circle (parallel to the ground) at a constant speed. The radius of this circular path *R* is 0.36 m. If the stone is traveling at 1.88 m/s, what is the angle θ between the string and the vertical direction?

D

(a) 15°
(b) 30°
(c) 37°
[✓ (d) 45°]
(e) 53°
(f) None of the above



$\sum F_y = 0$

$T\cos\theta = mg$

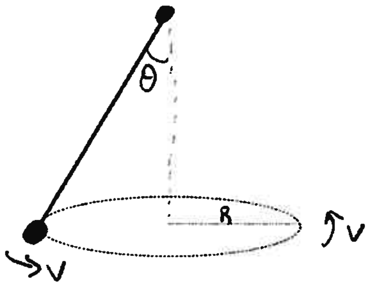
$T = \frac{mg}{\cos\theta}$

$\sum F_x = ma$

$T\sin\theta = ma$

$\cancel{m}g\tan\theta = \cancel{m}a$

$\tan\theta = \frac{v^2}{Rg} = \frac{(1.88\,m/s)^2}{(0.36\,m)(9.8\,m/s^2)} = 1.00 \quad \theta = 45°$



3. A person who has weight *w* on earth's surface travels to a remote planet. That new planet has a mass that is half of the earth's mass and a radius that is twice the earth's radius. What is the weight of the person close to the new planet's surface?

A

[✓ (a) $w/8$]
(b) $w/4$
(c) $w/2$
(d) w
(e) $2w$
(f) $4w$
(g) $8w$

$W_E = mg_E$

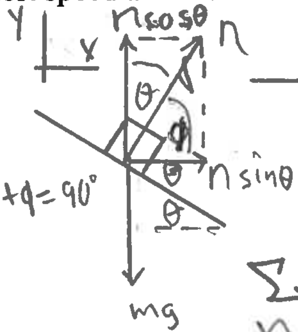
$g_p = G\frac{m_p}{R_p^2} = G\frac{\frac{1}{2}m_E}{(2R_E)^2} = \frac{1}{8}G\frac{m_E}{R_E^2} = \frac{1}{8}g_E$

$W_p = mg_p = \frac{1}{8}mg_E = \frac{1}{8}W_E$

4. A car drives around a curve in a frictionless, banked road as depicted in the figure below, where the road makes an angle of 30° with respect to the horizontal. If the curve has a radius $R = 50.0$ m, then what is the fastest speed at which the car can drive?

D

(a) 13.5 m/s
(b) 14.6 m/s
(c) 15.7 m/s
[✓ (d) 16.8 m/s]
(e) 22.1 m/s



$\theta+\phi=90°$

$a=\frac{v^2}{R}$

$\Sigma F_y = ma_y$

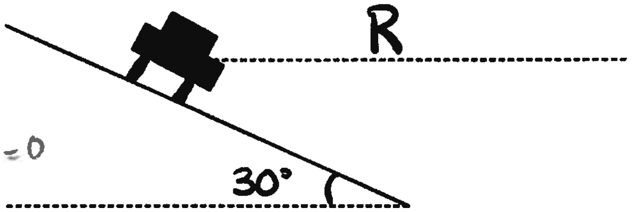
$n\cos\theta - mg = 0$

$n=\frac{mg}{\cos\theta}$

$\Sigma F_x = ma_x$

$n\sin\theta = ma$

$\cancel{m}g\tan\theta = \cancel{m}a$



$\frac{v^2}{R} = g\tan\theta$

$v=\sqrt{Rg\tan\theta} = \sqrt{(50)(9.8)\tan 30°} = 16.8\text{m/s}$

5. A satellite with a mass 4.2×10^5 kg is in a circular orbit around the earth. The mass of the earth is 5.97×10^{24} kg. If the satellite has an orbital radius of 6.78×10^6 m, how long does it take for the satellite to complete one orbit?

D

(a) 80 s
(b) 2.1×10^3 s
(c) 5.0×10^3 s
[✓ (d) 5.6×10^3 s]
(e) 6.2×10^3 s

$$G\frac{mm_E}{r^2} = m\frac{v^2}{r}$$

$$V=\sqrt{\frac{Gm_E}{r}} = \sqrt{\frac{(6.67\times10^{-11})(5.97\times10^{24})}{6.78\times10^6}} = 7664\text{ m/s}$$

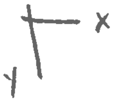
$$T=\frac{2\pi r}{v} = \frac{2\pi(6.78\times10^6)}{7664} = 5.6\times10^3\text{ s}$$

6. On an unknown planet, you drop a ball from rest at a height of 2.0 m and it takes 1.0 s for it to fall. If the planet has the same mass as the earth, 5.97×10^{24} kg, then what is its radius?

E

(a) 5.7×10^6 m
(b) 6.4×10^6 m
(c) 7.1×10^6 m
(d) 7.8×10^6 m
[✓ (e) 10.0×10^6 m]

$$g_p = G\frac{m_p}{R_p^2} \qquad R_p=\sqrt{\frac{Gm_p}{g_p}}$$



$y-y_0 = 2\text{m}$

$t = 1\text{s}$

$V_{oy} = 0$

$a_y = g = ?$

$$y-y_0 = \cancel{V_{oy}t} + \frac{1}{2}a_y t^2$$

$$a_y = \frac{2(y-y_0)}{t^2} = \frac{2(2\text{m})}{(1\text{ s})^2} = 4\text{ m/s}^2$$

$$R_p = \sqrt{\frac{(6.67\times10^{-11})(5.97\times10^{24})}{4}} = 10.0\times10^6\text{m}$$

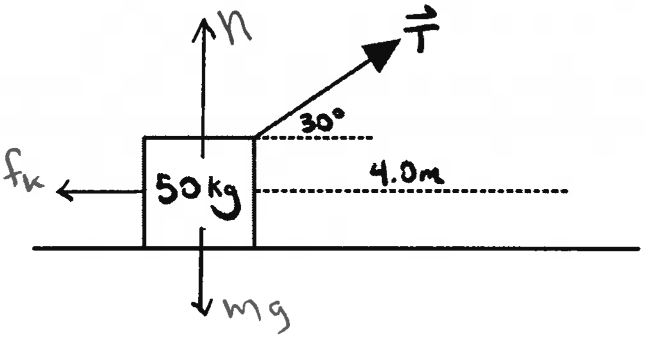
7. A 2.0 kg block slides down a 1.36 m ramp with unknown coefficient of friction, and the ramp makes an angle of 36.9° with respect to the horizontal. If the block has a speed of 1.0 m/s at the top of the ramp and a speed of 3.0 m/s at the bottom, then what is the net work done on the block by external forces as it slides down?

$$W_{tot} = K_f - K_i = \frac{1}{2}(2)(3)^2 - \frac{1}{2}(2)(1)^2 = 9-1 = 8\text{J}$$

B

(a) + 16 J
[✓ (b) + 8.0 J]
(c) 0 J
(d) − 8.0 J
(e) − 16 J

The following applies to problems 8 and 9:
A crate with a mass of 50. 0 kg is pulled across a flat floor a distance of 4. 0 m. The box is pulled by a rope making an angle of 30° above the horizontal with a constant tension force of 300 N. As the box is pulled, what is the work done by



8. The normal force?

C

(a) + 1960 J
(b) + 1360 J
[✓ (c) 0 J]
(d) – 1360 J
(e) – 1960 J

$W = Fs\cos\phi$

$\phi = 90°, W = 0$

9. The tension force?

D

(a) 0 J
(b) 460 J
(c) 600 J
[✓ (d) 1040 J]
(e) 1200 J

$W = (300N)(4m)\cos 30° = 1040 J$

10. Two objects, one of mass 2. 0 kg (object 1) and one of mass 4. 0 kg (object 2), are dropped from the top of MPHY, at a height of 40 m. If air resistance can be ignored, then what is true about the two objects just before hitting the ground?

$U_i = K_f$ $\quad U_{i1} = (2)(9.8)(40)$ $\quad U_{i2} = (4)(9.8)(4$

D

(a) The heavier object will have one-fourth the kinetic energy of the lighter one ($K_2 = K_1/4$)
(b) The heavier object will have half the kinetic energy of the lighter one ($K_2 = K_1/2$)
(c) The two objects will have the same kinetic energy ($K_2 = K_1$)
[✓ (d) The heavier object will have twice the kinetic energy of the lighter one ($K_2 = 2K_1$)]
(e) The heavier object will have four times the kinetic energy of the lighter one ($K_2 = 4K_1$)

$U_{i2} = 2U_{i1}$

so $K_{f2} = 2K_{f1}$

11. A small block with mass m slides on the frictionless track shown in the sketch, starting from rest at point A. The circular loop has radius R and the block starts at an initial height equal to three times the radius, $h = 3R$. When the block passes through the top part of the loop (point B), what is the normal force (magnitude and direction) from the track acting on the block?

$K_A + U_A + W_{other} = K_B + \cancel{U_B}$ $\quad V_A = 0$

$Y_A = R, Y_B = 0$

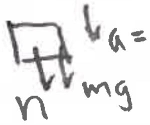
D

(a) $2mg$ upward
(b) mg upward
(c) The normal force has zero magnitude
[✓ (d) mg downward]
(e) $2mg$ downward

$\cancel{m} g R = \frac{1}{2} \cancel{m} V_B^2$

$V_B^2 = 2gR$

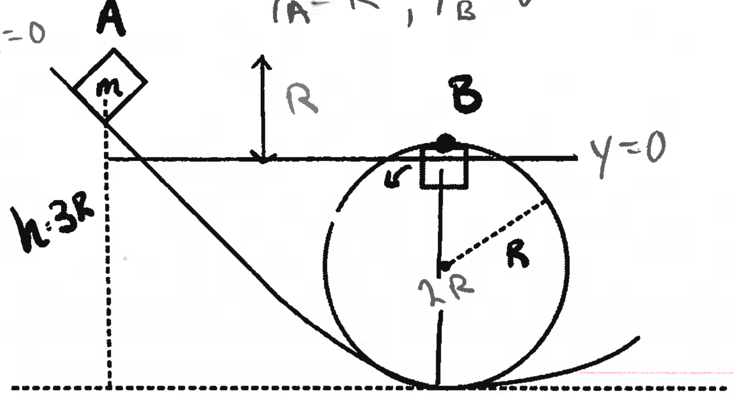
a+B



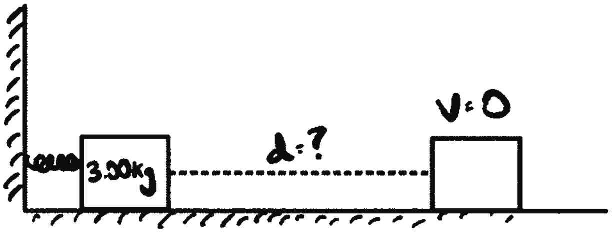
$a = \frac{v^2}{R} = \frac{2gR}{R} = 2g$

$n + mg = m(2g)$

$n = mg$



12. A 3.00 kg block on a horizontal surface is placed (not attached) at rest against a horizontal spring ($k = 2000$ N/m), compressed by a distance $x = 0.20$ m. The spring is released and the block begins to slide across the surface with a coefficient of kinetic friction equal to 0.4. How far does the block slide before coming to rest?



✓ (a) 1.7 m
B [✓ (b) 3.4 m]
~~(c) 5.1 m~~
(d) 6.8 m
(e) 8.5 m

$U_i = \frac{1}{2}kx_i^2 = \frac{1}{2}(2000)(0.2)^2$

$U_i = 40J$

$U_i + \cancel{K_i} + W_{other} = \cancel{U_f} + \cancel{K_f}$

$W_{other} = W_{f_k} = -f_k d = -\mu_k mg d$

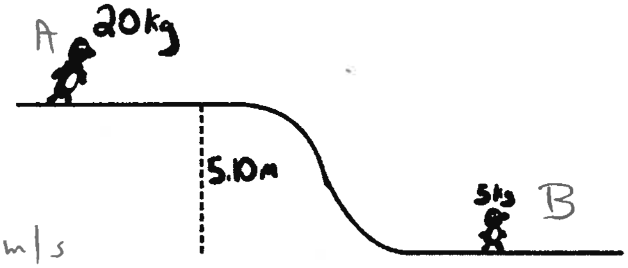
$40J - \mu_k mgd = 0$ $\quad d = \frac{40J}{(0.4)(3)(9.8)} = 3.4m$

13. An elevator with a total mass of 1300 kg, including passengers, travels upwards a total distance of 50 m in 30 seconds at constant speed. What is the average power output of the elevator in this time?

$P = \frac{W}{t} = \frac{mgh}{t} = \frac{(1300)(9.8)(50)}{30} = 2.1 \times 10^4 W$

(a) $3.8 \cdot 10^3$ W
(b) $7.6 \cdot 10^3$ W
D (c) $1.5 \cdot 10^4$ W
[✓ (d) $2.1 \cdot 10^4$ W]
(e) $6.4 \cdot 10^5$ W

14. A mother penguin slides down an icy hill (starting at rest) with height 5.10 m, scooping up her baby at the bottom of the hill. If the mother has a mass of 20 kg and the baby has a mass of 5 kg, what is the speed of the two of them after their ‘collision’?



(a) 2.5 m/s
(b) 5.7 m/s
C ✓ [✓ (c) 8.0 m/s]
(d) 10 m/s
(e) 13 m/s

Speed before collision

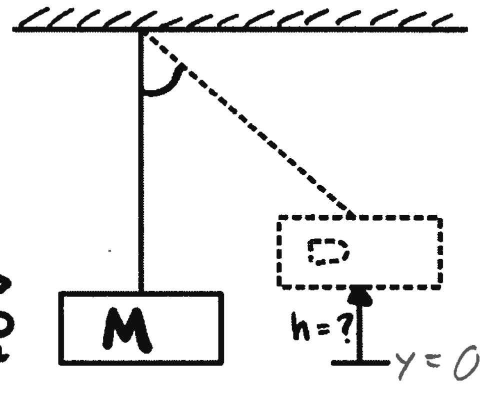
$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2$

$v = \sqrt{2gh} = \sqrt{2(9.8)(5.1)} = 10.0 m/s$

$m_A v_{Ai} = (m_A + m_B) v_f$

$v_f = \frac{(20)(10)}{25} = 8.0 m/s$

15. In a “ballistic pendulum,” a bullet with mass $m = 0.040$ kg and speed $v = 200$ m/s embeds itself in a block with mass $M = 1.96$ kg hanging from a string, causing it to swing. When the block swings to its greatest height, how much higher is it than when it was freely hanging?



B

(a) 0.016 m
[✓ (b) 0.82 m]
(c) 5.9 m
(d) 41 m
(e) 2040 m

Collision

$mv_i = (m+M)V$

$V = \left(\frac{0.04}{2}\right)(200) = 4\ m/s$

motion after collision

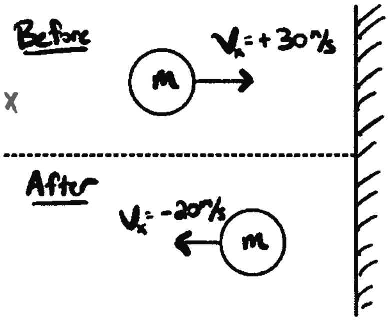
$v_i = 4\ m/s \quad v_f = 0$

$y_i = 0$, $y_f = h$, only gravity does work

$K_i + \cancel{U_i} + \cancel{W_{other}} = \cancel{K_f} + U_f$

$\frac{1}{2}\cancel{m}v_i^2 = \cancel{m}gh \qquad h = \frac{v_i^2}{2g} = \frac{(4)^2}{2(9.8)} = 0.82\ m$

16. A bouncy ball with mass $m = 0.50$ kg is traveling to the right at a speed of 30 m/s when it bounces into a wall. After bouncing, it is traveling to the left at a speed of 20 m/s. What is the impulse of the net force on the ball during its collision with the wall?



B

(a) 25 kg m/s to the right
[✓ (b) 25 kg m/s to the left]
(c) 5.0 kg m/s to the right
(d) 5.0 kg m/s to the left
(e) None of the above

impulse $= Ft = \Delta p$

y x

$Ft = mv_f - mv_i$

$Ft = (0.5)(-20) - (0.5)(30)$

$Ft = -10 - 15 = -25\ kg\cdot m/s$

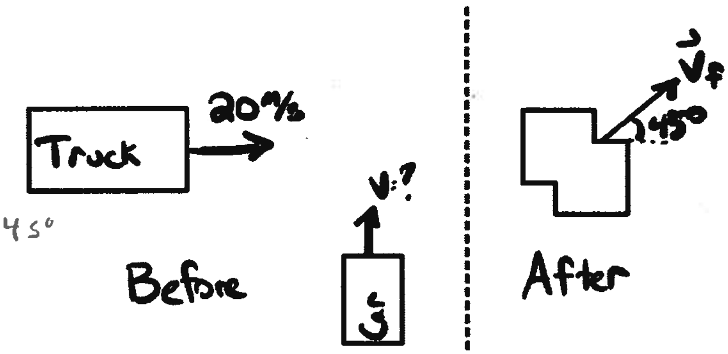
to the left

17. On an icy road, a truck with a mass of 2400 kg is traveling due east at a speed of 20.0 m/s when it collides with a car with a mass of 1600 kg traveling due north. The wreck of the two cars travels in a direction 45° north of east. What was the speed of the car just before the collision?

D

(a) 8.00 m/s
(b) 13.3 m/s
(c) 20.0 m/s
[✓ (d) 30.0 m/s]
(e) 38.3 m/s

y x



$P_{ix} = P_{fx}$

$(2400)(20) = 4000\ V_f \cos 45°$

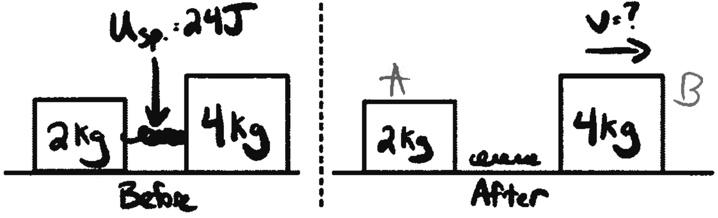
$V_f \cos 45° = 12\ m/s$

$P_{iy} = P_{fy}$

$(1600) V_{car} = (4000) V_f \sin 45°$

$\cos 45° = \sin 45°$ so $V_{car} = \frac{(4000)(12)}{1600} = 30\ m/s$

18. Two blocks, with masses 2.00 kg and 4.00 kg, are held at rest on a horizontal, frictionless surface with a compressed spring between them. The spring stores 24.0 J of elastic potential energy. The two blocks are released from rest and move off in opposite directions. What is the final speed of the 4.00 kg block after leaving the spring?



A

[✓ (a)] 2. 0 m/s
(b) 4. 0 m/s
(c) 8. 0 m/s
(d) 16. 0 m/s
(e) None of the above

$\frac{1}{2}(2)V_A^2 + \frac{1}{2}(4)V_B^2 = 24J$

$2V_A = 4V_B$

$V_A = 2V_B$

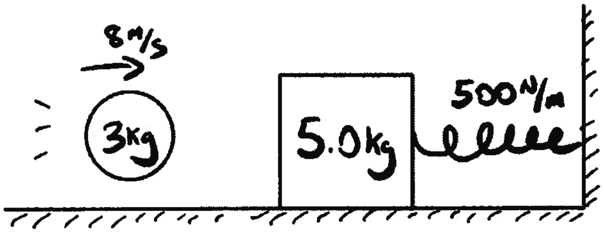
$\frac{1}{2}(2)(2V_B)^2 + \frac{1}{2}(4)V_B^2 = 24$

$4V_B^2 + 2V_B^2 = 24$

$V_B^2 = 4$

$V_B = 2 m/s$

19. A projectile with mass 3.0 kg and speed 8.0 m/s is fired at a block (sitting on a frictionless table) with mass 5.0 kg next to an uncompressed spring with a force constant 500 N/m. The projectile sticks to the block, causing it to slide into the spring. What is the maximum distance by which the block will compress the spring?



C

(a) 23 cm
(b) 30 cm
[✓ (c)] 38 cm
(d) 62 cm
(e) 80 cm
(f) 101 cm

collision

$(3)(8) = 8V_f$

$V_f = 3 m/s$

$\frac{1}{2}mV_f^2 = \frac{1}{2}kx^2$

$x^2 = \frac{8(3)^2}{500} = 0.144m^2$

$x = 0.381 m$

20. A small car collides head-on with a large truck. Which of the following statements is correct about their collision, considering the “system” to be the car and the truck?

B

(a) Linear momentum and kinetic energy are both conserved
[✓ (b)] Linear momentum is conserved, but kinetic energy is not conserved
(c) Kinetic energy is conserved, but linear momentum is not conserved
(d) Neither linear momentum nor kinetic energy is conserved