Physics 211 Test 2A

Section 1: Dr. Gladden, Oct. 6, 2010

NAME: KEY   UM ID#: ____________

Conceptual Multiple Choice (*2 points each*): Clearly write the letter corresponding to the BEST possible answer in the space provided. You may also circle the answer to be sure.

1. C Is it possible for an object moving with a constant speed to accelerate? Explain.
   A) No, if the speed is constant then the acceleration is equal to zero.
   B) No, an object can accelerate only if there is a net force acting on it.
   C) Yes, although the speed is constant, the direction of the velocity can be changing.
   D) Yes, if an object is moving it can experience acceleration

2. B Consider a particle moving with constant speed such that its acceleration of constant magnitude is always perpendicular to its velocity.
   A) It is moving in a straight line.
   B) It is moving in a circle.
   C) It is moving in a parabola.
   D) None of the above is definitely true all of the time.

3. B Consider a particle moving with constant speed such that its acceleration of constant magnitude is always perpendicular to its velocity.
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   B) It is moving in a circle.
   C) It is moving in a parabola.
   D) None of the above is definitely true all of the time.

4. A A roller coaster car is on a track that forms a circular loop in the vertical plane. If the car is to just maintain contact with track at the top of the loop, what is the minimum value for its centripetal acceleration at this point?
   A) g downward
   B) 0.5g downward
   C) g upward
   D) 2g upward

5. A A car goes around a curve of radius r at a constant speed v. What is the direction of the net force on the car?
   A) toward the curve's center
   B) away from the curve's center
   C) toward the front of the car
   D) toward the back of the car

6. D Can work be done on a system if there is no motion?
   A) Yes, if an outside force is provided.
   B) Yes, since motion is only relative.
   C) No, since a system which is not moving has no energy.
   D) No, because of the way work is defined.

7. D A 50-N object was lifted 2.0 m vertically and is being held there. How much work is being done in *holding* the box in this position?
   A) more than 100 J
   B) 100 J
   C) less than 100 J, but more than 0 J
   D) 0 J

8. D Does the centripetal force acting on an object do work on the object?
   A) Yes, since a force acts and the object moves, and work is force times distance.
   B) Yes, since it takes energy to turn an object.
   C) No, because the object has constant speed.
   D) No, because the force and the displacement of the object are perpendicular.

9. C On a plot of Force versus position (F vs. x), what represents the work done by the force F?
   A) the slope of the curve
   B) the length of the curve
   C) the area under the curve
   D) the product of the maximum force times the maximum x

10. A If the net work done on an object is negative, then the object's kinetic energy
   A) decreases.
   B) remains the same.
   C) increases.
   D) is zero.

11. B Car J moves twice as fast as car K, and car J has half the mass of car K. The kinetic energy of car J, compared to car K is
   A) the same.
   B) 2 to 1.
   C) 4 to 1.
   D) 1 to 2.

12. B An object hits a wall and bounces back with half of its original speed. What is the ratio of the final kinetic energy to the initial kinetic energy?
A) 1/2
B) 1/4
C) 2
D) 4

13. A You slam on the brakes of your car in a panic, and skid a certain distance on a straight, level road. If you had been traveling twice as fast, what distance would the car have skidded, under the same conditions?
A) It would have skidded 4 times farther.
B) It would have skidded twice as far.
C) It would have skidded 1.4 times farther.
D) It is impossible to tell from the information given.

14. B Is it possible for a system to have negative potential energy?
A) Yes, as long as the total energy is positive.
B) Yes, since the choice of the zero of potential energy is arbitrary.
C) No, because the kinetic energy of a system must equal its potential energy.
D) No, because this would have no physical meaning.

15. D The total mechanical energy of a system
A) is equally divided between kinetic energy and potential energy.
B) is either all kinetic energy or all potential energy, at any one instant.
C) can never be negative.
D) is constant, only if conservative forces act.

16. C Describe the energy of a car driving up a hill.
A) entirely kinetic
B) entirely potential
C) both kinetic and potential
D) gravitational

17. C Consider two masses m1 and m2 at the top of two frictionless inclined planes. Both masses start from rest at the same height. However, the plane on which m1 sits is at an angle of 30 with the horizontal, while the plane on which m2 sits is at 60. If the masses are released, which is going faster at the bottom of its plane?
A) m1
B) m2
C) They both are going the same speed.
D) cannot be determined without knowing the masses

18. A A ball drops some distance and gains 30 J of kinetic energy. Do not ignore air resistance. How much gravitational potential energy did the ball lose?
A) more than 30 J
B) exactly 30 J
C) less than 30 J
D) cannot be determined from the information given

19. A Of the following, which is not a unit of power?
A) watt/second
B) newton-meter/second
C) joule/second
D) watt

20. D Compared to yesterday, you did 3 times the work in one-third the time. To do so, your power output must have been
A) the same as yesterday's power output.
B) one-third of yesterday's power output.
C) 3 times yesterday's power output.
D) 9 times yesterday's power output.

Test B key

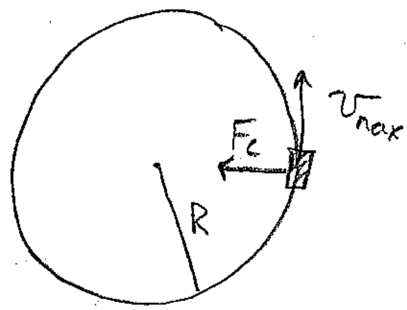
1. D
2. D
3. C
4. B
5. A
6. B
7. A
8. D
9. C
10. A
11. B
12. A
13. D
14. D
15. B
16. B
17. C
18. C
19. A
20. A

Problems: Work each of the following problems. Make sure to **show your work** and put a box around your final answer.

1. (*20 points*) You need to design a rotary traffic circle on a flat space (no incline or banking). The radius of the biggest possible circle in the space available is 30.0 m. The typical coefficient of static friction between a tire and concrete is 0.9.

   (a) What is the fastest speed a car can go around the circle and not skid out?

Centripetal force (F_c) is supplied by friction



$$F_c = F_f$$

$$M\frac{v_{max}^2}{R} = \mu_s F_N = \mu_s M g$$

so $\frac{v_{max}^2}{R} = \mu_s g$

$$v_{max} = \sqrt{\mu_s R g} = \sqrt{0.9(30.0\,m)(9.8\,m/s^2)} = \boxed{16.3\,m/s}$$

   (b) On a rainy day, the coefficient of friction reduces to about 0.6. What will the new maximum speed of the car be?

From above,

$$v_{max} = \sqrt{\mu_s R g} \rightarrow$$

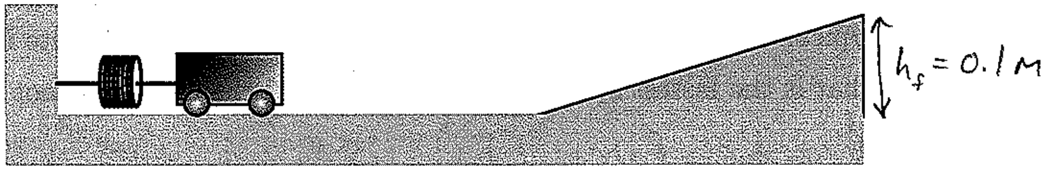
$$= \sqrt{0.6(30.\,m)(9.8\,m/s^2)}$$

$$= 13.3\,m/s$$

We see $v_{max} \propto \sqrt{\mu_s}$

so for instance, if μ_s drops by a factor of 4, v_{max} drops by a factor of 2.

2. (*20 points*) A 0.50 Kg toy car is propelled by a spring gun with spring constant $k = 80 N/m$ and maximum compression of 12.0 cm. The car is fired at a ramp with a vertical height of 10 cm at the end. Ignore friction and the rotation of the wheels.



(a) What will be the speed of the car as it launches off the ramp?

$$K_i + U_i + W_{nc} = K_f + U_f$$

$$0 + \frac{1}{2}k\Delta x^2 + 0 = \frac{1}{2}m v_f^2 + m g h_f$$

$$\text{so } v_f = \sqrt{\frac{k\Delta x^2 - 2 m g h_f}{m}}$$

$$v_f = \sqrt{\frac{80\frac{N}{m}(0.12m)^2 - 2(0.5kg)(9.8\frac{m}{s^2})(0.1m)}{0.5\,kg}}$$

$$v_f = 0.59\ m/s$$

(b) What will be the maximum height of the car during it's trajectory through the air if the launch angle off the ramp is 30°?

At max height, $v = v_x = v_0 \cos\theta$, so it still has some kinetic energy.

Start at end of ramp:

$$K_i + U_i + W_{nc} = K_f + U_f$$

want h_f.

$$\frac{1}{2}m v_0^2 + m g h_0 = \frac{1}{2}m v_x^2 + m g h_f$$

$$\text{so } h_f = \frac{1}{g}\left[\frac{1}{2}v_0^2 + g h_0 - \frac{1}{2}v_0^2\cos^2\theta\right] = \frac{1}{g}\left[\frac{1}{2}v_0^2\sin^2\theta + g h_0\right]$$

$$= \frac{v_0^2\sin^2\theta}{2g} + h_0 = \frac{(0.59\,m/s)^2\sin^2(30°)}{2(9.8\,m/s^2)} + 0.1m = 0.1044m = \boxed{10.44\,cm}$$

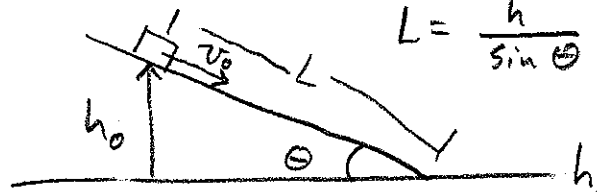
our old friend from chap. 4!

3.2 kg

3. (*20 points*) A crate is pushed down a ramp with an angle of 25° so that it has a velocity of 2.5 m/s down the ramp at the top of the ramp. The vertical height at that point is 3.0 m and the coefficient of friction between the ramp and crate is 0.2.

(a) Will the crate make it to the bottom before stopping? (Show your work to get credit!)

$L = \frac{h}{\sin\Theta} = 7.1\,m$



Test if total initial Mechanical energy is greater than energy lost due to friction

$K_0 + U_0 + W_{NC} \overset{?}{>} 0$

$\frac{1}{2} m v_0^2 + m g h_0 + F_f \cdot L \cos\phi \overset{?}{>} 0$

φ is angle b/t F + L, 180° in this case so we have $-\mu_k m g \cos\Theta L$

so

$\frac{1}{2} m v_0^2 + m g h_0 - \mu_k m g \cos\Theta L \overset{?}{>} 0$

$m\left[\frac{1}{2}(2.5\,m/s)^2 + (9.8\,m/s^2)(3.0\,m) - 0.2\,(9.8\,\frac{m}{s^2})\cos 25°(7.1\,m)\right] \overset{?}{>} 0$

$3.2[3.13 + 29.4 - 12.6] \overset{?}{>} 0$

$64\,J > 0$ so Yes!

(b) If so, how fast will it be going? If not, how far will it slide (down the ramp) before stopping?

Speed at bottom of ramp is v_f.

By Conservation of energy

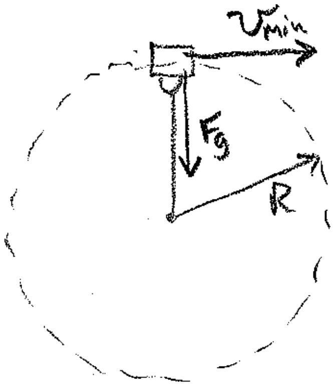
$K_0 + U_0 + W_{NC} = K_f + U_f$ ($U_f \to 0$)

$64\,J = \frac{1}{2} m v_f^2$

$v_f = \sqrt{\frac{2(64\,J)}{(3.2\,kg)}}$

$\boxed{v_f = 6.3\,m/s}$

Extra Credit (5 points)
You swing a bucket of water over your head. You have 0.8 m long arms. What is the minimum speed the bucket must have so that the water does not fall out?



To maintain a circular path, when $v = v_{min}$ at top, centripetal force is fully supplied by gravity (no force is required from your arm).

So

$$F_c = F_g$$

$$\frac{m v_{min}^2}{R} = mg$$

$$v_{min} = \sqrt{Rg}$$

$$= \sqrt{0.8m(9.8 m/s^2)}$$

$$\boxed{v_{min} = 2.8 \ m/s}$$