Practice Problems for Physics 111 Common Exam 3, Fall 2023
Chapter 7, 8, 9 and Rolling Without Slipping

1. A 3.0-kg ball with an initial velocity of (4**i** + 3**j**) m/s collides with a wall and rebounds with a velocity of (–4**i** + 3**j**) m/s. What is the impulse exerted on the ball by the wall?

A) +24**i** N s
B) –24**i** N s
C) +18**j** N s
D) –18**j** N s
E) +8.0**i** N s

2. An 80-g particle moving with an initial speed of 50 m/s in the positive *x* direction strikes and sticks to a 60-g particle moving 50 m/s in the positive *y* direction. What is the magnitude of the velocity of the composite system after the collision?

A) 36 m/s
B) 50 m/s
C) 75 m/s
D) 86 m/s
E) 11 m/s

3. A merry-go-round rotates from rest with an angular acceleration of 1.56 rad/s^2. How long does it take to rotate through the first 2 rev?

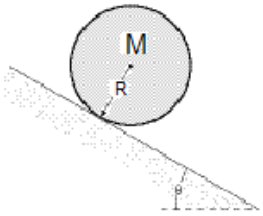
A) 2 s
B) 4 s
C) 6 s
D) 8 s
E) 10 s

4. A wheel, with radius R = 0.5 m, initially has an angular velocity of 2.5 rev/s, and is slowing down at a rate of 2 rad/s^2. By the time it stops spinning about its center, what distance will a point on the outer rim have traveled?

A) 12 m
B) 18 m
C) 24 m
D) 31 m
E) 47 m

5. A solid ball of mass of 0.25 kg rolls without slipping 4 m down an incline that makes an angle of 25^0 a with a horizontal. If it starts from rest, what is its kinetic energy at the bottom of the incline ?

A) 1 J
B) 2 J
C) 4 J
D) 6 J
E) 8 J



6. A basketball is rolling without slipping along a horizontal surface with total kinetic energy 20 J. How much energy (in Joules) is due to the rotational kinetic energy of the ball about its center of mass? Basketballs are hollow shells. ($I = 2/3\ mr^2$.)

A) 10
B) 8
C) 13.3
D) 4
E) 12

7. A projectile is launched from the ground level with initial speed of 140 m/s at some angle to horizontal. What will be the speed of the projectile when it reaches elevation of 500 m (assume the launch angle is sufficient for the projectile to reach this elevation or higher; neglect air resistance). Hint: use energy conservation.

Ans. 100 m/s

8. A 10-kilogram bicycle wheel is rotating at 60 rev/min. It is essentially a thin hoop with a radius of 0.5 meters and a rotational inertia $I = mr^2$. How much work must be done to bring it to a stop?

Ans. 49.35 J.

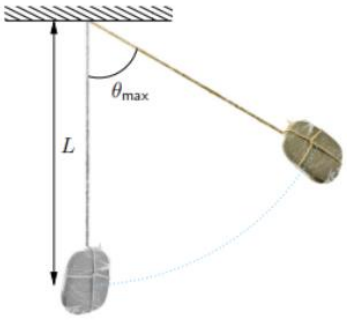
9. You throw a ball with a mass of 0.40 kg against a brick wall. It is moving horizontally to the left at 30 m/s when it hits the wall; it rebounds horizontally to the right at 20 m/s. Find the impulse of the net external force on the ball during its collision with the wall.

Ans. 20 N·s

10. In the previous problem, if the ball is in contact with the wall for 0.010 s, find the average horizontal force that the wall exerts on the ball during the impact.

Ans. 2000 N

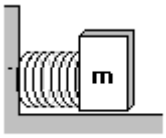
11. A small rock with mass 0.12 kg is fastened to a massless string with length 0.80 m to form a pendulum. The pendulum is swinging so as to make a maximum angle of 45° with the vertical. Air resistance is negligible. What is the speed of the rock when the string passes through the vertical position? Ans. 2.1 m/s



12. A 10-kg object is dropped from rest. After falling a distance of 50 m, it has a speed of 26 m/s. How much work is done by the dissipative (air) resistive force on the object during this descent?

A) –1.3 kJ
B) –1.5 kJ
C) –1.8 kJ
D) –2.0 kJ
E) –2.3 kJ

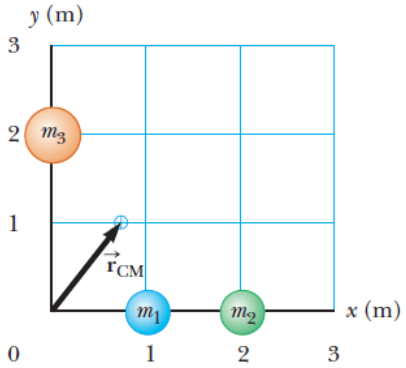
13. A horizontal spring with a 10000 N/m spring constant is compressed 0.08 m, and a 12-kg block is placed against it. When the block is released, the block shoots forward along a horizontal surface that exerts 8 N friction force on the block. How far from the original position does the block travel before coming to a stop?



A) 3.2 m
B) 4.0 m
C) 6.4 m
D) 7.0 m
E) 8.0 m

14. A system consists of three particles with masses $m_1 = m_2 = 1.0$ kg and $m_3 = 2.0$ kg. located as shown in Figure. Find the coordinates of the center of mass of the system.

Ans. x_{cm}=0.75 m, y_{cm}= 1.0 m



15. A certain pendulum consists of a 2-kg mass swinging at the end of a string (length = 2.0 m). At the lowest point in the swing the tension in the string is equal to 30 N. What angle will the string make with a vertical when the mass reaches its maximum height?

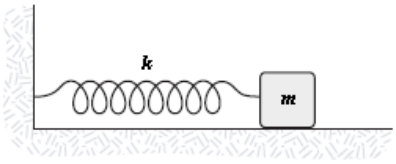
A) 42.7^0
B) 28.4^0
C) $12\ .5^0$
D) 56^0
E) $8.8\ ^0$

16. Two small spheres, each with mass 0.0200 kg, are connected by a light 1.60 m long rod. The spheres rotate about an axis that is perpendicular to the rod at its center. What is the angular speed of the spheres if the total kinetic energy is 1.28 J? Ans. 10 rad/s

17. A 2.0-kg block sliding on a horizontal frictionless surface is attached to one end of a horizontal spring (k = 200 N/m) which has its other end fixed. If the block has a speed of 4.0 m/s as it passes through the equilibrium position, what is its speed when it is 20 cm from the equilibrium position?

a. 2.6 m/s
b. 3.1 m/s
c. 3.5 m/s
d. 1.9 m/s
e. 2.3 m/s

18. The block shown is released from rest when the spring is stretched a distance *d*. If k = 50 N/m, m = 0.50 kg, d = 10 cm, and the coefficient of kinetic friction between the block and the horizontal surface is equal to 0.25, determine the speed of the block when it first passes through the position for which the spring is unstretched.



a. 92 cm/s
b. 61 cm/s
c. 71 cm/s
d. 82 cm/s
e. 53 cm/s

19. At t = 0 the current to a dc electric motor is reversed, resulting in an angular displacement of the motor shaft given by $\boldsymbol{\theta(t) = (250\ rad/s)t - (20.0\ rad/s^2)t^2 - (1.50\ rad/s^3)t^3}$. (a) At what time is the angular velocity of the motor shaft zero? (b) Calculate the angular acceleration at the instant that the motor shaft has zero angular velocity. (c) How many revolutions does the motor shaft turn through between the time when the current is reversed and the instant when the angular velocity is zero? (d) How fast was the motor shaft rotating at t = 0, when the current was reversed? (e) Calculate the average angular velocity for the time period from t = 0 to the time calculated in part (a). **Ans. (a) 4.23s; (b) -78.1rad/s^2; (c) 586rad= 93.3 rev; (d) 250 rad/s; (e) 138 rad/s**

Answer Key

1. **B**
2. **A**
3. **B**
4. **D**
5. **C**
6. **B**
7. **100m/s**
8. **49.35 J**
9. **20 N.s**
10. **2000 N**
11. **2.1 m/s**

12. B
13. B
14. x_{cm}=0.75 m, y_{cm}= 1.0 m
15. A
16. 10 rad/s
17. C
18. C
19. (a) 4.23s; (b) -78.1rad/s2; (c) 586rad= 93.3 rev; (d) 250 rad/s; (e) 138 rad/s