Instructor(s): *Acosta, Rinzler*

PHYSICS DEPARTMENT

PHY 2048, Spring 2014 — Final Exam — April 26, 2014

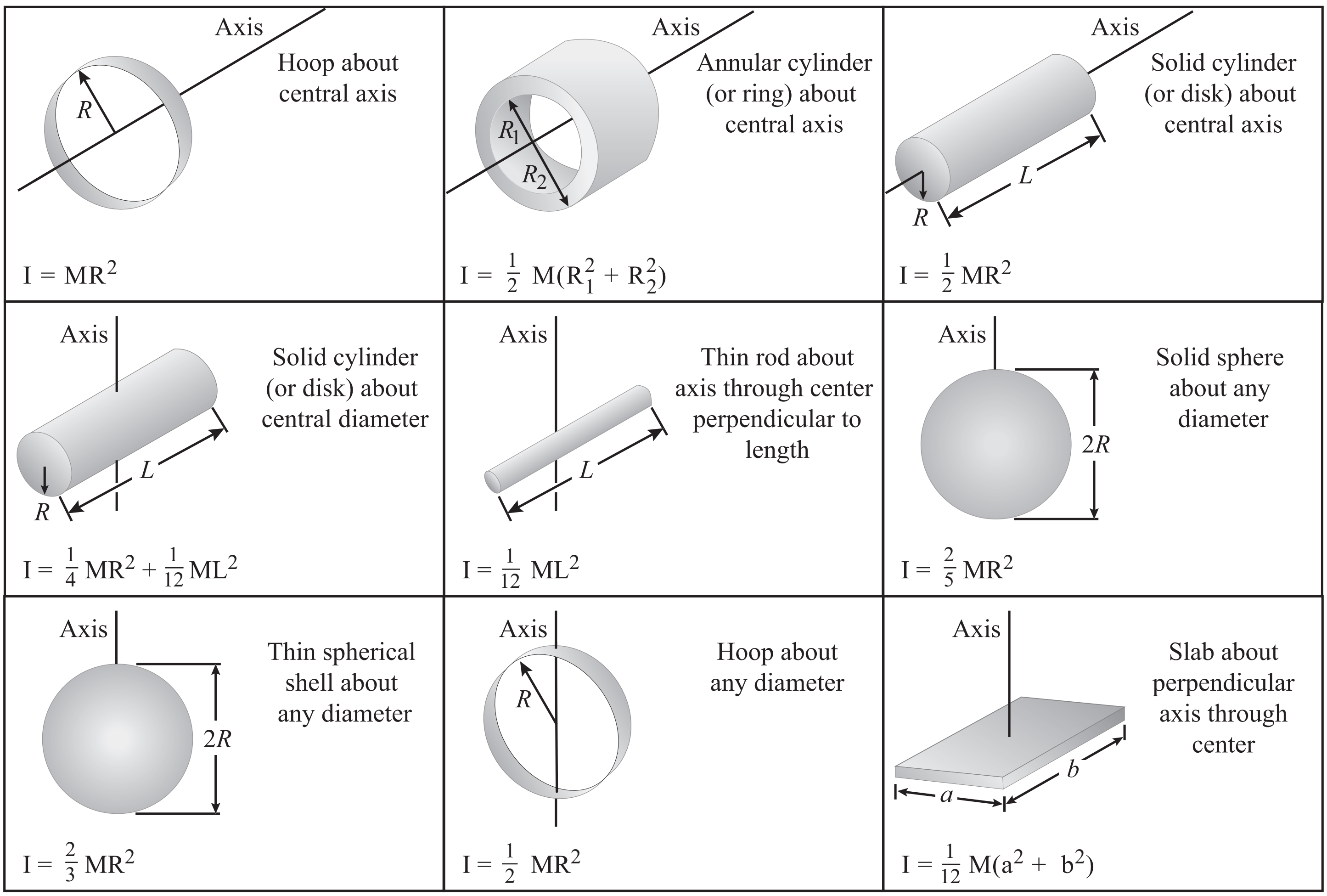
Name (print, last first): ______________________ Signature: ______________________

On my honor, I have neither given nor received unauthorized aid on this examination.

YOUR TEST NUMBER IS THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE.

(1) **Code your test number on your answer sheet (use lines 76–80 on the answer sheet for the 5-digit number)**. Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your UFID number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) Do all scratch work anywhere on this exam that you like. **Circle your answers on the test form.** At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout.
(4) **Blacken the circle of your intended answer completely, using a #2 pencil or blue or black ink**. Do not make any stray marks or some answers may be counted as incorrect.
(5) **The answers are rounded off. Choose the closest to exact. There is no penalty for guessing. If you believe that no listed answer is correct, leave the form blank.**
(6) Hand in the answer sheet separately.

Where needed use $g = 9.80\ \mathrm{m/s^2}$



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1. In a hydraulic lever consisting of two ideal fluid filled cylinder/pistons with a fluid filled line coupling the two cylinders, the output force is 100 times the input force. For 1 Joule of work done on the input side, the work done on the output side is (in J):

   (1) 1 (2) 100 (3) 1/100 (4) $\sqrt{100}$ (5) need displacements to answer

2. The density of a particular grade of steel is 7900 kg/m^3. A cube of this steel has 10.0 cm side lengths but is *missing* a cubical *interior* volume with 3.00 cm side lengths. The apparent weight of the block under water (density 1000 kg/m^3) is (in N):

   (1) 65.5 (2) 62.7 (3) 57.9 (4) 50.9 (5) 53.2

3. The density of a particular grade of steel is 7900 kg/m^3. A cube of this steel has 10.0 cm side lengths but is *missing* a cubical *interior* volume with 4.00 cm side lengths. The apparent weight of the block under water (density 1000 kg/m^3) is (in N):

   (1) 62.7 (2) 65.5 (3) 57.9 (4) 50.9 (5) 53.2

4. The density of a particular grade of steel is 7900 kg/m^3. A cube of this steel has 10.0 cm side lengths but is *missing* a cubical *interior* volume with 5.00 cm side lengths. The apparent weight of the block under water (density 1000 kg/m^3) is (in N):

   (1) 57.9 (2) 62.7 (3) 65.5 (4) 50.9 (5) 53.2

5. A mass M hanging by a spring executes simple harmonic oscillations at a natural frequency of 5 Hz. A mass of $0.20M$ is *added* to M and the system set into motion again. The *period* of the oscillations after addition of the mass is (in milliseconds):

   (1) 219 (2) 228 (3) 237 (4) 209 (5) need M and k of spring to answer

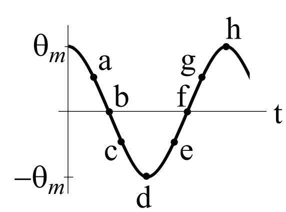
6. A mass M hanging by a spring executes simple harmonic oscillations at a natural frequency of 5 Hz. A mass of $0.30M$ is *added* to M and the system set into motion again. The *period* of the oscillations after addition of the mass is (in milliseconds):

   (1) 228 (2) 219 (3) 237 (4) 209 (5) need M and k of spring to answer

7. A mass M hanging by a spring executes simple harmonic oscillations at a natural frequency of 5 Hz. A mass of $0.40M$ is *added* to M and the system set into motion again. The *period* of the oscillations after addition of the mass is (in milliseconds):

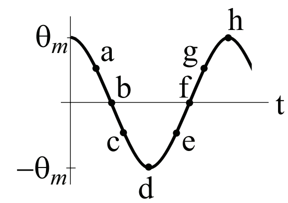
   (1) 237 (2) 219 (3) 228 (4) 209 (5) need M and k of spring to answer

8. The figure plots the angular displacement for a torsion pendulum undergoing simple harmonic oscillations: $\theta = \theta_m \cos\left(\sqrt{\frac{\kappa}{I}}t\right)$. Referring to the labeled points on the plot, the magnitude of the angular acceleration is greatest at:



   (1) d and h (2) a and c (3) b and f (4) e and g (5) a, c, e, and g

9. The figure plots the angular displacement for a torsion pendulum undergoing simple harmonic oscillations: $\theta = \theta_m \cos\left(\sqrt{\frac{\kappa}{I}}t\right)$. Referring to the labeled points on the plot, the magnitude of the angular velocity is greatest at:



(1) b and f (2) a and c (3) d and h (4) e and g (5) a, c, e, and g

10. A uniform solid sphere of mass 0.4 kg and diameter 10 cm rolls from rest without slipping down a 30° incline. After rolling 8.0 m, measured along the incline, its *translational* kinetic energy (in J) is:

(1) 11.2 (2) 14.0 (3) 16.8 (4) 19.6 (5) 22.4

11. A uniform solid sphere of mass 0.4 kg and diameter 10 cm rolls from rest without slipping down a 30° incline. After rolling 10.0 m, measured along the incline, its *translational* kinetic energy (in J) is:

(1) 14.0 (2) 11.2 (3) 16.8 (4) 19.6 (5) 22.4

12. A uniform solid sphere of mass 0.4 kg and diameter 10 cm rolls from rest without slipping down a 30° incline. After rolling 12.0 m, measured along the incline, its *translational* kinetic energy (in J) is:

(1) 16.8 (2) 11.2 (3) 14.0 (4) 19.6 (5) 22.4

13. One object is shot vertically upwards with an initial velocity of 70 m/s. Another object is shot vertically upwards with a velocity of 10 m/s. The first object climbs to a maximum height that is Q times the maximum height of the second object. Q is:

(1) 49 (2) 64 (3) 81 (4) 100 (5) 121

14. One object is shot vertically upwards with an initial velocity of 80 m/s. Another object is shot vertically upwards with a velocity of 10 m/s. The first object climbs to a maximum height that is Q times the maximum height of the second object. Q is:

(1) 64 (2) 49 (3) 81 (4) 100 (5) 121

15. One object is shot vertically upwards with an initial velocity of 90 m/s. Another object is shot vertically upwards with a velocity of 10 m/s. The first object climbs to a maximum height that is Q times the maximum height of the second object. Q is:

(1) 81 (2) 49 (3) 64 (4) 100 (5) 121

16. A ball is thrown horizontally from the top of a cliff from a height of 40.0 m above a level plain with a speed of 15 m/s. It strikes the plain with a velocity vector that makes an acute angle (in degrees) with respect to the horizontal of:

(1) 62 (2) 60 (3) 58 (4) 56 (5) 54

17. A ball is thrown horizontally from the top of a cliff from a height of 35.0 m above a level plain with a speed of 15 m/s. It strikes the plain with a velocity vector that makes an acute angle (in degrees) with respect to the horizontal of:

(1) 60 (2) 62 (3) 58 (4) 56 (5) 54

18. A ball is thrown horizontally from the top of a cliff from a height of 30.0 m above a level plain with a speed of 15 m/s. It strikes the plain with a velocity vector that makes an acute angle (in degrees) with respect to the horizontal of:

(1) 58 (2) 62 (3) 60 (4) 56 (5) 54

19. While driving at a constant speed of 12 m/s around a traffic circle having a radius of 45 m, a small mass dangling by a string from your rear view mirror would hang at an angle with respect to the vertical (in degrees) of:

(1) 18 (2) 21 (3) 24 (4) 14 (5) 26

20. While driving at a constant speed of 13 m/s around a traffic circle having a radius of 45 m, a small mass dangling by a string from your rear view mirror would hang at an angle with respect to the vertical (in degrees) of:

(1) 21 (2) 18 (3) 24 (4) 14 (5) 26

21. While driving at a constant speed of 14 m/s around a traffic circle having a radius of 45 m, a small mass dangling by a string from your rear view mirror would hang at an angle with respect to the vertical (in degrees) of:

(1) 24 (2) 18 (3) 21 (4) 14 (5) 26

22. A cylindrical bar aligned along the x-axis has a mass density that increases quadratically along its length: $\mu(x) = (2.00\ \text{kg/m}^3)x^2$. If the bar extends from $x = 0$ to $x = 1.20$ m, at what position along the x-axis (in m) is the center-of-mass of the bar?

(1) 0.90 (2) 0.98 (3) 1.05 (4) 1.13 (5) 0.83

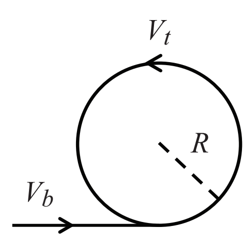
23. A cylindrical bar aligned along the x-axis has a mass density that increases quadratically along its length: $\mu(x) = (2.00\ \text{kg/m}^3)x^2$. If the bar extends from $x = 0$ to $x = 1.30$ m, at what position along the x-axis (in m) is the center-of-mass of the bar?

(1) 0.98 (2) 0.90 (3) 1.05 (4) 1.13 (5) 0.83

24. A cylindrical bar aligned along the x-axis has a mass density that increases quadratically along its length: $\mu(x) = (2.00\ \text{kg/m}^3)x^2$. If the bar extends from $x = 0$ to $x = 1.40$ m, at what position along the x-axis (in m) is the center-of-mass of the bar?

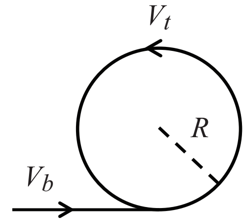
(1) 1.05 (2) 0.90 (3) 0.98 (4) 1.13 (5) 0.83

25. A roller coaster is to go through a vertical loop as shown. What is the minimum speed (in m/s) at the bottom of the loop (V_b) necessary so that the cars do not fall off of the track at the top of the loop if the radius of the loop is $R = 7.00$ m? Treat a roller coaster car as a point mass going through the loop.



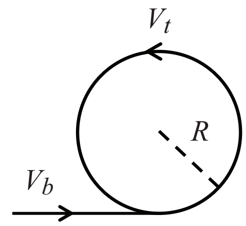
(1) 18.5 (2) 19.8 (3) 21.0 (4) 22.1 (5) 23.2

26. A roller coaster is to go through a vertical loop as shown. What is the minimum speed (in m/s) at the bottom of the loop (V_b) necessary so that the cars do not fall off of the track at the top of the loop if the radius of the loop is $R = 8.00$ m? Treat a roller coaster car as a point mass going through the loop.



(1) 19.8 (2) 18.5 (3) 21.0 (4) 22.1 (5) 23.2

27. A roller coaster is to go through a vertical loop as shown. What is the minimum speed (in m/s) at the bottom of the loop (V_b) necessary so that the cars do not fall off of the track at the top of the loop if the radius of the loop is $R = 9.00$ m? Treat a roller coaster car as a point mass going through the loop.



(1) 21.0 (2) 18.5 (3) 19.8 (4) 22.1 (5) 23.2

28. A time dependent position vector is given by $\vec{r}(t) = (6.00\text{ m/s})t\hat{i} + (2.00\text{ m/s}^2)t^2\hat{j}$. The magnitude and angle (with respect to the +x axis) of the instantaneous velocity vector at $t = 2.00$ s (in m/s and degrees, respectively) are:

(1) 10.0, 53° (2) 13.4, 63° (3) 11.3, 37° (4) 6.30, 18° (5) 7.20, 34°

29. A time dependent position vector is given by $\vec{r}(t) = (6.00\text{ m/s})t\hat{i} + (2.00\text{ m/s}^2)t^2\hat{j}$. The magnitude and angle (with respect to the +x axis) of the instantaneous velocity vector at $t = 3.00$ s (in m/s and degrees, respectively) are:

(1) 13.4, 63° (2) 10.0, 53° (3) 11.3, 37° (4) 6.30, 18° (5) 7.20, 34°

30. A puck shot at 9.0 m/s across effectively frictionless ice hits a 10 m long patch in which the coefficient of kinetic friction is 0.20. The puck's speed (in m/s) when it leaves the patch is:

(1) 6.5 (2) 5.0 (3) 3.1 (4) 1.9 (5) it does not get across the patch

31. A puck shot at 8.0 m/s across effectively frictionless ice hits a 10 m long patch in which the coefficient of kinetic friction is 0.20. The puck's speed (in m/s) when it leaves the patch is:

(1) 5.0 (2) 6.5 (3) 3.1 (4) 1.9 (5) it does not get across the patch

32. A puck shot at 7.0 m/s across effectively frictionless ice hits a 10 m long patch in which the coefficient of kinetic friction is 0.20. The puck's speed (in m/s) when it leaves the patch is:

(1) 3.1 (2) 6.5 (3) 5.0 (4) 1.9 (5) it does not get across the patch

33. The transverse displacement along a string from a traveling wave has the form $y(x,t) = y_m \sin(kx - \omega t)$, where y_m is 0.5 cm, k is 100 m^{-1}, and ω is $30,000$ rad/s. What is the maximum transverse speed of any particular point along the string?

(1) 150 m/s (2) 300 m/s (3) $15,000$ m/s (4) 3×10^6 m/s (5) 5×10^{-3} m/s

34. The string on a musical instrument has a length of 30 cm. If it is set to vibrate at its lowest standing wave harmonic, the frequency of the vibrations is 200 Hz. If the tension on the string is doubled, what is the new frequency for the same lowest order harmonic?

(1) 280 Hz (2) 200 Hz (3) 400 Hz (4) 140 Hz (5) 100 Hz

35. The string on a musical instrument has a length of 30 cm. If it is set to vibrate at its lowest standing wave harmonic, the frequency of the vibrations is 200 Hz. If the tension on the string is reduced to one-half of its original value, what is the new frequency for the same lowest order harmonic?

(1) 140 Hz (2) 200 Hz (3) 400 Hz (4) 280 Hz (5) 100 Hz

36. You are trying to record a conversation for a film, but unfortunately the microphone you are using is situated exactly between two obnoxiously loud speakers that are both emitting background sound waves at a frequency of 1000 Hz. Each speaker is 2 m away to the left and right of the microphone, respectively, and both speakers emit their sound waves in phase with each other and at the same amplitude. If you are only allowed to move one speaker closer to the microphone, by how much should you move that speaker toward it in order to reduce the volume of this background sound to a minimum? Take the velocity of sound in air to be 340 m/s.

(1) 0.17 m (2) 0.34 m (3) 2.0 m (4) 0.085 m (5) 0.68 m

37. Assume that all ambulance sirens emit sound at a frequency of 1600 Hz. While lying in bed, you hear a siren at a frequency of 1530 Hz. Is the ambulance moving toward or away from your location, and what is its speed along the line of sight direction? Take the velocity of sound in air to be 340 m/s.

(1) away, 15.6 m/s (2) toward, 15.6 m/s (3) away, 6.3 m/s (4) toward, 6.3 m/s (5) away, 11 m/s

38. Assume that all ambulance sirens emit sound at a frequency of 1600 Hz. While lying in bed, you hear a siren at a frequency of 1630 Hz. Is the ambulance moving toward or away from your location, and what is its speed along the line of sight direction? Take the velocity of sound in air to be 340 m/s.

(1) toward, 6.3 m/s (2) toward, 15.6 m/s (3) away, 6.3 m/s (4) away, 15.6 m/s (5) away, 11 m/s

39. Suppose that a drill is able to reach a depth below the Earth s surface equal to 10% of the radius of the Earth (*i.e.,* a distance from the center of the Earth equal to 90% of the radius). What is the acceleration due to gravity at the bottom of this shaft?

(1) 8.8 m/s^2 (2) 12 m/s^2 (3) 7.9 m/s^2 (4) 9.8 m/s^2 (5) 7.1 m/s^2

40. In order to return future astronauts from Mars back to Earth, any rocket must be launched from the surface of that planet with enough speed to escape the gravitational pull. What is the escape speed from Mars if its radius is 3390 km and its mass is 6.42×10^{23} kg? ($G = 6.674 \times 10^{-11}$ N m^2/kg^2)

(1) 5.0 km/s (2) 3.6 km/s (3) 11 km/s (4) 1.6×10^5 km/s (5) 2.5×10^7 km/s

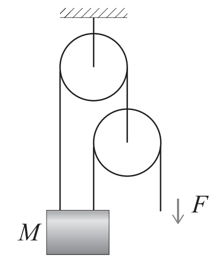
41. A cart of mass 0.3 kg moving on a frictionless linear air track at an initial speed of 2 m/s undergoes an elastic collision with a stationary cart of the same mass. What is the speed of the center of mass of the two-cart system after the collision?

(1) 1 m/s (2) 2 m/s (3) 4 m/s (4) 0 m/s (5) 1.4 m/s

42. A cart of mass 0.3 kg moving on a frictionless linear air track at an initial speed of 4 m/s undergoes an elastic collision with a stationary cart of the same mass. What is the speed of the center of mass of the two-cart system after the collision?

(1) 2 m/s (2) 1 m/s (3) 4 m/s (4) 0 m/s (5) 1.4 m/s

43. A force $\vec{F}$ of magnitude 15 N as shown in the figure keeps the hanging block of mass M and the massless pulleys in equilibrium. What is the mass M?



(1) 4.6 kg
(2) 1.5 kg
(3) 3.1 kg
(4) 6.1 kg
(5) 0.75 kg

FOLLOWING GROUPS OF QUESTIONS WILL BE SELECTED AS ONE GROUP FROM EACH TYPE
TYPE 1
Q# S 2
Q# S 3
Q# S 4
TYPE 2
Q# S 5
Q# S 6
Q# S 7
TYPE 3
Q# S 8
Q# S 9
TYPE 4
Q# S 10
Q# S 11
Q# S 12
TYPE 5
Q# S 13
Q# S 14
Q# S 15
TYPE 6
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TYPE 12
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TYPE 13
Q# S 37
Q# S 38
TYPE 14
Q# S 41
Q# S 42