PHY2053 PHYSICS
Final Exam

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

Given Information:

$g = 9.8$ m/s^2 $G = 6.67 \times 10^{-11}$ Nm^2/kg^2 1 atmosphere $= 1.01 \times 10^5$ Pa

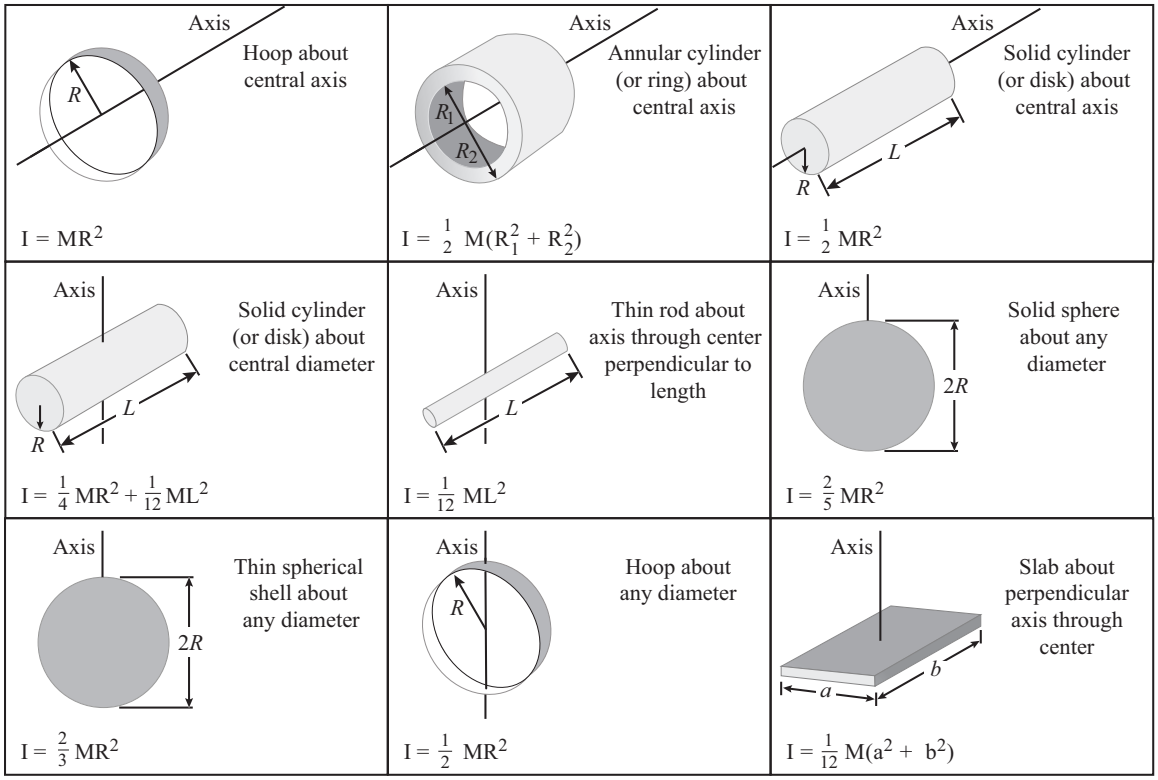
1 m = 100 cm 1 kg = 1000 g 1 inch $= 2.54 \times 10^{-2}$ m 1 foot = 12 inches

1 day = 24 hours 1 hour = 60 minutes 1 minute = 60 seconds

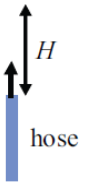
$A = \pi r^2$ $C = 2\pi r$ 1 rev $= 2\pi$ radians π radians $= 180°$

speed of sound in air = 340 m/s density of water = 1000 kg/m^3

density of steel = 7860 kg/m^3 density of oil = 800 kg/m^3



1. A garden hose of inner radius 0.60 cm carries water at 1.8 m/s. The nozzle at the end has radius R and is held in a vertical position as shown in the figure. If the water rises a height $H = 2$ m above the nozzle, what is the radius R of the nozzle (in cm)?

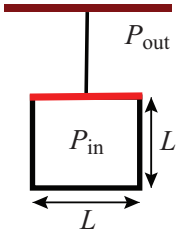


(1) 0.32 (2) 0.26 (3) 0.23 (4) 0.15 (5) 0.60

2. An object hangs from a spring balance. When submerged in water (density ρ_{water}) the object weighs 4 N and when submerged in a liquid with a specific gravity of 0.5 (*i.e.*, $\rho/\rho_{\text{water}} = 0.5$) the object weighs 8 N. What is the weight of the object in air? (neglect the density of air)

(1) 12 N (2) 9 N (3) 14 N (4) 2 N (5) 16 N

3. A cubical metal box with sides of mass M and length L has a square lid also with mass M and length L. The lid is not attached to the box, however, the lid and the box form an airtight seal. Near the surface of the Earth, the lid is held at rest by a steel cable, as shown in the figure. The pressure outside the box is the atmospheric pressure, $P_{\text{out}} = P_{\text{atm}} = 101$ kPa. The box is partially evacuated to an inside pressure $P_{\text{in}} = 85$ kPa. If $L = 0.2$ m, what is the maximum mass M (in kg) of the sides of the cubical metal box such that the box remains at rest and does not fall?



(1) 13.06 (2) 4.90 (3) 8.98 (4) 2.65 (5) 18.89

4. Stan and Ollie are standing next to a train track. Stan puts his ear to the steel track to hear the train coming. When the train is 750 m away, he hears the sound of the train whistle through the track 2.1 s before Ollie hears it through the air. If the speed of sound in steel is 5790 m/s, what is the temperature of the air (in °C)?

(1) 9.0 (2) 23.3 (3) 37.9 (4) 18.2 (5) 15.5

5. As a race car passes the spectators at rest on the side of the track, the frequency of the sound of the engine after passing is 0.5 times what it was before. How fast is the race car moving (in m/s)? (Take the speed of sound in the air to be 343 m/s.)

(1) 114.3 (2) 85.8 (3) 49.0 (4) 94.6 (5) 29.6

6. What is the intensity of a 70 dB sound wave. The threshold of hearing is 1.0×10^{-12} W/m^2.

(1) 1.0×10^{-5} W/m^2 (2) 7.0 W/m^2 (3) 1.8 W/m^2 (4) 1.0 W/m^2 (5) None of these.

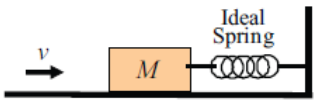
7. At a distance of 2 m from a ringing bell, the intensity of sound is 0.1 W/m^2. At what distance from the bell is the intensity 0.01 W/m^2?

(1) 6.3 m (2) 20 m (3) 0.63 m (4) 10 m (5) None of these.

8. Two immiscible fluids (oil and water) are placed into a long tube sealed at one end and with the other end open to the atmosphere. The tube is vertical. The water at the bottom of the tube is 12.5 m tall and on top of the water the oil is 15 m tall. What is the absolute pressure at the bottom of the tube?

(1) 3.4×10^5 Pa (2) 2.4×10^5 Pa (3) 1.2×10^5 Pa (4) 1.8×10^5 Pa (5) None of these.

9. A block of mass $M = 4$ kg is at rest on a horizontal frictionless surface and is connected to an ideal spring as shown in the figure. A 2-gram bullet traveling horizontally at 290 m/s strikes the block and becomes embedded in the block. If the bullet-block system comes to rest after compressing the spring a distance of 4 cm, what is the period (in s) of the subsequent simple harmonic motion of the system?

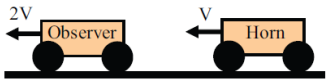


(1) 1.73 (2) 2.60 (3) 3.47 (4) 0.87 (5) 4.95

10. An ideal spring-and-mass system is undergoing simple harmonic motion (SHM). If the speed of the block is 1.0 m/s when the displacement from equilibrium is 2.0 m, and the speed of the block is 3.0 m/s when the displacement from equilibrium is 1.0 m, what is the angular frequency of the oscillations (in rad/s)?

(1) 1.63 (2) 2.24 (3) 2.83 (4) 1.00 (5) 3.95

11. A large horn with fundamental frequency $f_0 = 500$ Hz is mounted on a car that is moving to the left at speed V. An observer in another car is moving to the left at speed 2V as shown in the figure. If the speed of sound in the air is 343 m/s and V = 20 m/s, what frequency does the observer hear?



(1) 469.0 Hz (2) 452.1 Hz (3) 434.0 Hz (4) 395.6 Hz (5) 527.5 Hz

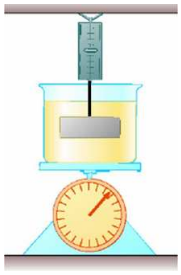
12. A simple pendulum has a length L. If its period is T when it is on the surface of the Earth (gravitational acceleration g), what is its period when it is on the surface of a planet with gravitational acceleration equal to $g/4$?

(1) 2T (2) 4T (3) T/2 (4) T/4 (5) T

13. A simple harmonic oscillator consists of a block of mass 2 kg attached to a spring of spring constant 200 N/m. If the speed of the block is 40 m/s when the displacement from equilibrium is 3 m, what is the amplitude of the oscillations?

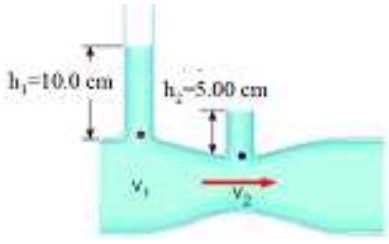
(1) 5 m (2) 4 m (3) 3 m (4) 6 m (5) 10 m

14. A 3.00-kg beaker containing 2.00 kg of oil (density = 916 kg/m^3) rests on a scale that measures weight. A 2.00-kg block of iron (density = 7.86×10^3 kg/m^3) is suspended from a spring scale and is completely submerged in the oil. Find the equilibrium reading of the bottom scale.



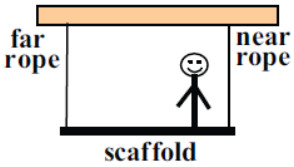
(1) 51.3 N
(2) 31.7 N
(3) 17.3 N
(4) 132 N
(5) 4.9 N

15. The inside diameters of the larger portions of the horizontal pipe depicted in the figure are 2.50 cm. Water flows to the right at a rate of 1.80×10^{-4} m^3/s. Determine the velocity v_2.



(1) 1.06 m/s
(2) 2.43 m/s
(3) 3.71 m/s
(4) 5.71 m/s
(5) 8.23 m/s

16. A billboard worker with a weight of 700 N stands on a uniform scaffold with length $L = 5$ m. The scaffold is supported by vertical ropes at each end as shown in the figure. If the scaffold weighs 500 N and the worker stands 1.0 m from one end, what is the tension (in N) in the rope farthest from the worker?



(1) 390 (2) 810 (3) 730 (4) 1200 (5) 250

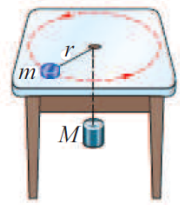
17. A 0.5-kg rubber ball is dropped from rest a height of 18.6 m above the surface of the Earth. It strikes the sidewalk below and rebounds up to a maximum height H. If the magnitude of the impulse due to the collision with the sidewalk is 16.73 N·s, what is the height H (in meters)?

(1) 10.5 (2) 4.9 (3) 2.4 (4) 12.6 (5) 19.6

18. An elevator of mass 600 kg starts from rest at $t = 0$ and moves downward. The tension in the supporting cable is constant and equal to 5,000 N. What is the elevator's displacement (in m) between $t = 0$ and $t = 5$ s?

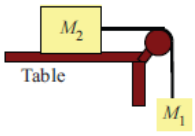
(1) 18.3 (2) 39.2 (3) 60.0 (4) 52.2 (5) 10.5

19. A puck of mass $m = 2$ kg slides in a circle of radius $r = 2.0$ m on a frictionless table while attached to a hanging cylinder of mass M by a cord through a hole in the table, as shown in the figure. If the hanging cylinder is at rest when the period of the circular motion is 2.5 s, what is the mass M (in kg) of the cylinder?



(1) 2.58 (2) 7.16 (3) 4.03 (4) 8.65 (5) 1.89

20. A block of mass $M_2 = 1$ kg on a horizontal surface is connected by a cord over a massless, frictionless pulley to a second block of mass M_1. The static and kinetic coefficient of friction between the table and mass M_2 are $\mu_s = 0.5$ and $\mu_k = 0.2$, respectively. If after the blocks are released from rest the tension in the cord is 7.84 N, what is the mass M_1 (in kg)?



(1) 2 (2) 3 (3) 4 (4) 1 (5) 0.5

21. A 0.21 kg, 0.24 m diameter disk is spun on an axle through its center by a motor. The motor supplies 0.059 Nm of torque to take the disk from 0 to 1800 rpm. How long does it take for the disk to reach the final angular velocity? Answer in seconds.

(1) 4.8 (2) 9.7 (3) 16.2 (4) 12.3 (5) 20.1

22. Driving at a steady highway speed the power meter on your Tesla (btw congrats on your high income) reads 15 kW. You calculate that you cover a distance of 140 m in 5 seconds. What is the net, constant, retarding force acting on the 1600 kg car (i.e. from friction and drag forces, in N)?

(1) 536 (2) 594 (3) 647 (4) 696 (5) 734

23. Mars completes one orbit around the Sun in 687 days. What is the distance between Mars and the Sun? Assume that the orbit is circular. Mass of the Sun is 1.99×10^{30} kg, mass of Mars is 6.39×10^{23} kg, and $G = 6.67 \times 10^{-11}$ N m^2 kg^2.

(1) 2.28×10^{11} m (2) 1.08×10^{11} m (3) 5.79×10^{10} m (4) 2.15×10^{10} m (5) 3.21×10^{12} m

24. A piano tuner stretches a steel piano wire with a tension of 500 N. The steel wire is 0.400 m long and has a mass of 3.00 g. What is frequency of its fundamental mode of vibration?

(1) 323 Hz (2) 645 Hz (3) 510 Hz (4) 1020 Hz (5) None of these.

25. If two sounds differ by 10 dB, find the ratio of the intensity of the lounder sound to the that of the softer one.

(1) 10 (2) 2.7 (3) 5.0 (4) 3.0 (5) None of these.