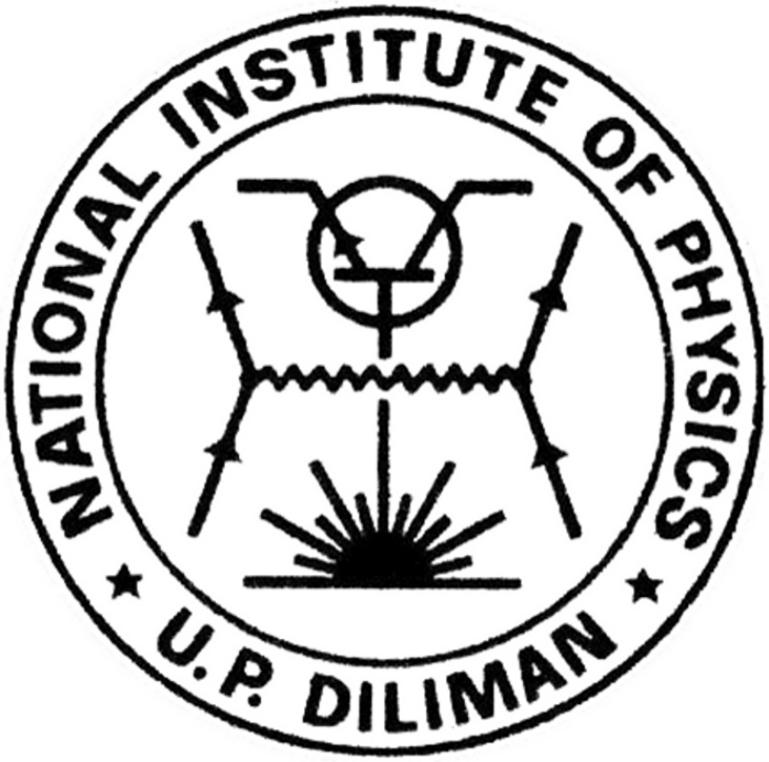
# University of the Philippines
# College of Science



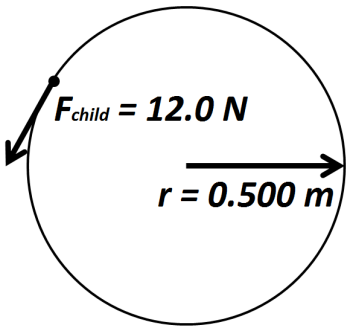

# Physics 71

## Set A
## Third Long Exam
## Second Semester, AY 2015–2016

| | |
|---|---|
| Name: | Instructor: |
| Section/Class Schedule: | Student Number: |
| Course: | College: |

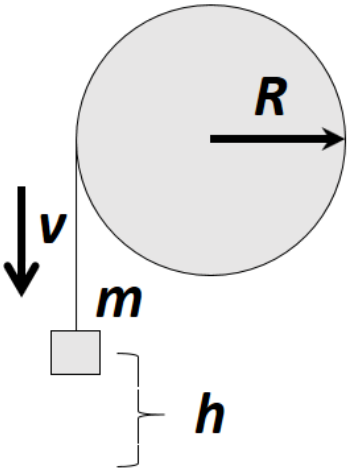
**Instructions:** Choose the letter of the best answer to each of the following questions. Use **PENCIL NUMBER 2** only to shade your answer to the exam.To change your answer, erase neatly your old answer and simply shade the new one. **Any form of cheating in examinations or any act of dishonesty in relation to studies, such as plagiarism, shall be subject to disciplinary action.** Whenever applicable, use $g = 9.80\,\mathrm{m/s^2}$ for the magnitude of acceleration due to gravity. Following instructions is part of the examination.

1. **Be Merry.** A child pushed the edge of a merry-go-round ($I = \frac{1}{2}MR^2$) that is initially at rest with a force of $12.\,\mathrm{N}$ as shown in the figure. What is the angular acceleration of the merry-go-round if it has mass of $10.\,\mathrm{kg}$ and radius of $0.50\,\mathrm{m}$?



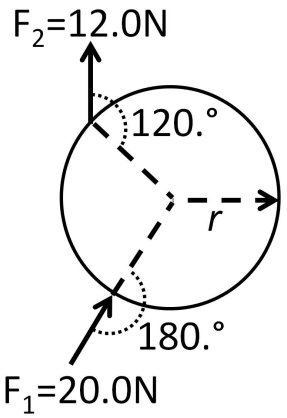

   A. $2.4\,\mathrm{rad/s^2}$
   C. $14.\,\mathrm{rad/s^2}$
   B. $4.8\,\mathrm{rad/s^2}$
   D. $29\,\mathrm{rad/s^2}$

2. **Catch me.** An object with mass $m$ is connected to an unstretchable string wrapped around a solid sphere with mass $m$ and radius $R$ $\left(I_{sphere} = \frac{2}{5}mR^2\right)$. What is the speed of the object after it descends height $h$ if the motion occurred without slipping and the sphere is free to rotate in fixed axis?




   A. $v = \sqrt{\dfrac{10gh}{7}}$
   C. $v = \sqrt{\dfrac{gh}{2}}$
   B. $v = \sqrt{\dfrac{7gh}{10}}$
   D. $v = \sqrt{2gh}$

3. **Circle of Life.** A uniform solid disk, pinned at its center, with mass $2.50\,\mathrm{kg}$ and radius $0.800\,\mathrm{m}$ is acted upon by two forces as shown. What is the magnitude of the angular acceleration of the disk? $\left(\text{Use } I_{cm} = \dfrac{1}{2}mr^2\right)$

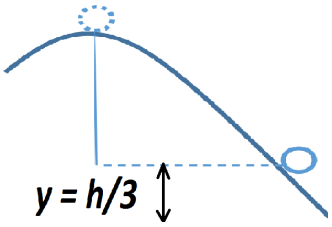



   A. $12.2\,\mathrm{rad/s^2}$
   C. $10.4\,\mathrm{rad/s^2}$
   B. $9.14\,\mathrm{rad/s^2}$
   D. $6.00\,\mathrm{rad/s^2}$

4. **RAMPage.** Two uniform solid spheres are placed at the same height $h$ on ramps with similar angle of inclination $\theta$. Sphere A slid down a frictionless ramp while sphere B rolled without slipping on the other ramp. What is the relationship between the center-of-mass speeds of spheres A and B at the bottom of the ramp?

   A. $v_A = v_B$
   B. $v_A > v_B$
   C. $v_A < v_B$
   D. Depends on the mass and radius

5. **Gulong- gulong.** A solid spherical ball ($I = \frac{2}{5}MR^2$) of mass $M$ and radius $R$, initially at rest, rolls down a rough hill without slipping. If its translational speed at bottom of the hill is $v$, what is its speed as it reaches $1/3$ of the height of the hill?




   A. $\sqrt{\frac{2}{3}}v$
   B. $\sqrt{\frac{1}{3}}v$
   C. $\frac{2}{3}v$
   D. $\frac{1}{3}v$

6. **Frosty the Snowball.** A $50.0$-kg snowball ($I_{CM} = \frac{2}{5}MR^2$) rolls down the side of a mountain with a constant slope of $30.0°$ from the horizontal. What is the frictional force needed so that it rolls without slipping?

   A. $70.0\,\mathrm{N}$
   B. $175\,\mathrm{N}$
   C. $121\,\mathrm{N}$
   D. $303\,\mathrm{N}$

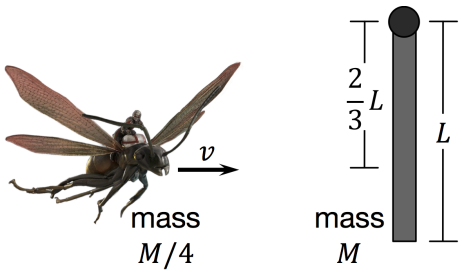
7. **Salamat friendship.** Wisely's dream to serve his country is now over. He then decided to let go of his banner and sing a goodbye song to his supporters. If the banner swings with an instantaneous angular speed of $2.00\,\mathrm{rad/s}$, what is the banner's angular momentum at this instant if its moment of inertia about an axis that passes through point O is $56.7\,\mathrm{kg \cdot m^2}$?


   A. $226\,\mathrm{kg \cdot m^2/s}$
   B. $113\,\mathrm{kg \cdot m^2/s}$
   C. $20.8\,\mathrm{kg \cdot m^2/s}$
   D. $3.34\,\mathrm{kg \cdot m^2/s}$

8. **UFO (uniform floating oh).** A long rod ($I_{\text{cm}} = \frac{1}{12}ML^2$) floats and spins in outer space about its center of mass with an angular speed $\omega$. What is its new angular speed when its length doubles?

A. $\frac{\omega}{2}$ B. $\frac{\omega}{4}$ C. $2\omega$ D. $4\omega$

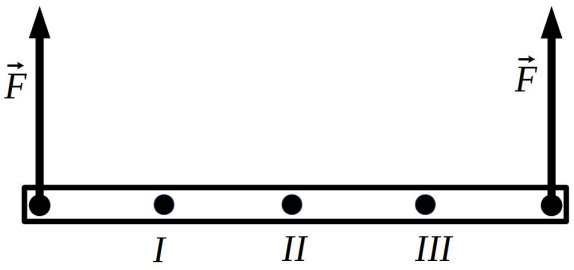
9. **Ant-Man on a Flying Ant.** A door of mass $M$ and length $L$ is initially at rest $\left(I = \frac{1}{3}ML^2\right)$. Ant-Man traveling perpendicular to the door with speed $v$ strikes the door at $2L/3$ away from the hinge and sticks on it. The mass of Ant-Man is $1/4$ the mass of the door. What is the final angular speed of the door just after the collision?



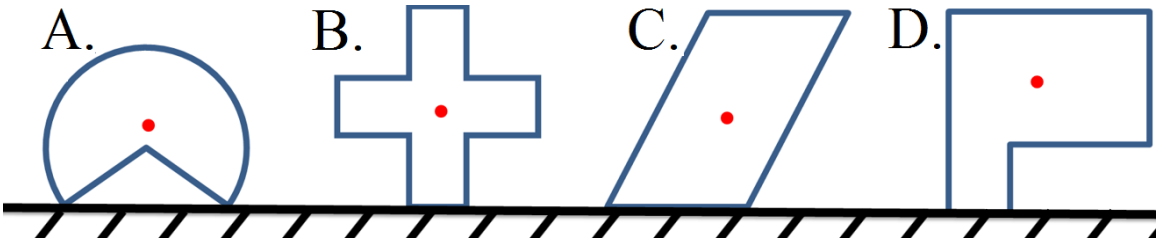

A. $\frac{3}{8} \cdot \frac{v}{L}$ B. $\frac{3}{4} \cdot \frac{v}{L}$ C. $\frac{3}{2} \cdot \frac{v}{L}$ D. $\frac{1}{2} \cdot \frac{v}{L}$

10. **Easylibrium.** Two forces of the same magnitude $F$ and direction are acting on a beam of negligible mass as shown. What should be the direction and point of application of the third force so that the beam is in equilibrium? The magnitude of the third force is $2F$

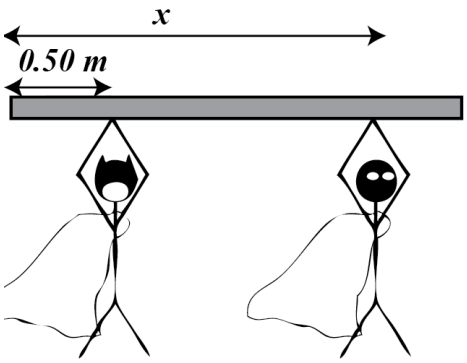
A. upward and acting at point I
B. downward and acting at point II
C. downward and acting at point III
D. upward and acting at point II




11. **Unstable.** Which of the four objects with uniform density will topple?



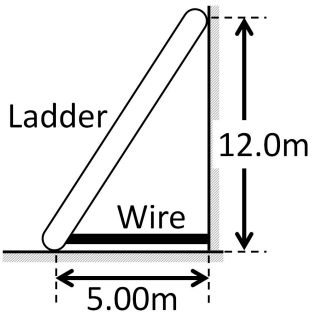
12. **Batman and Robin.** Batman and Robin are lifting a $196\,\mathrm{N}$ uniform board with a length of $2.50\,\mathrm{m}$. Batman exerts $55.0\,\mathrm{N}$ at a point $0.50\,\mathrm{m}$ from the left end. At what distance from left end of the board should Robin exert so that the board stays in equilibrium condition.




A. $1.54\,\mathrm{m}$ C. $0.500\,\mathrm{m}$

B. $1.04\,\mathrm{m}$ D. $1.25\,\mathrm{m}$

13. **Stairway to Uno.** A $110.\text{-}\,\mathrm{kg}$ uniform ladder is tied at its bottom on the wall using a wire as shown in the figure. The floor in the figure is frictionless, while the wall is rough. If the maximum tension on the wire is $180.\,\mathrm{N}$, what is the minimum coefficient of static friction between the wall and the ladder so that the ladder is in static equilibrium? ( $g = 9.80\,\mathrm{m/s^2}$)

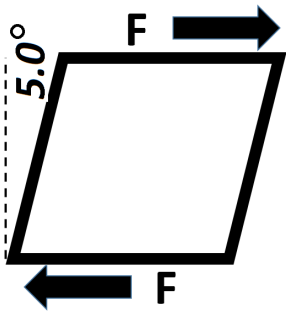



A. $0.582$ B. $0.594$ C. $2.25$ D. $9.53$

14. **SB.** A steel bar $\left(Y = 20 \times 10^{10}\,\mathrm{Pa}\right)$ with cross-sectional area $7.8 \times 10^{-5}\,\mathrm{m^2}$ and length $5.0 \times 10^{-2}\,\mathrm{m}$ is stretched until its length becomes $5.1 \times 10^{-2}\,\mathrm{m}$. How much force was applied on the steel bar?

A. $1.6 \times 10^5\,\mathrm{N}$ B. $6.3 \times 10^5\,\mathrm{N}$ C. $3.1 \times 10^5\,\mathrm{N}$ D. $1.3 \times 10^5\,\mathrm{N}$

15. **Pa-Shear naman!** A cubical metal sample $(S = 6.0 \times 10^9\,\mathrm{Pa})$ of length $45\,\mathrm{cm}$ is acted upon by a shear force which displaced the metal by an angle of $10.^\circ$ from its original shape. What is the magnitude of the shear force?




A. $1.1 \times 10^8\,\mathrm{N}$ C. $1.1 \times 10^9\,\mathrm{N}$

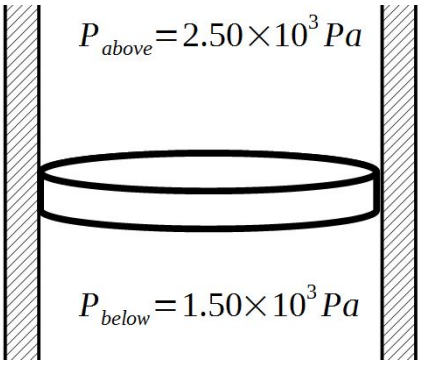
B. $2.4 \times 10^8\,\mathrm{N}$ D. $5.2 \times 10^9\,\mathrm{N}$

16. **Jelly Green Goo.** Flubber shrinks by $0.010\%$ of its original volume when the pressure is increased by $2.0 \times 10^4\,\mathrm{Pa}$. What is Flubber's bulk modulus?

A. $2.0 \times 10^6$ Pa C. $5.0 \times 10^{-6}$ Pa

B. $2.0 \times 10^8$ Pa D. $5.0 \times 10^{-8}$ Pa

17. **Under Pressure.** A 1.30-kg cylindrical lid of radius $5.00 \times 10^{-2}\,\mathrm{m}$ is trapped in a vertical tube. The pressures above and below the lid are $P_{\text{above}} = 2.50 \times 10^3\,\mathrm{Pa}$ and $P_{\text{below}} = 1.50 \times 10^3\,\mathrm{Pa}$, respectively. What is the net force acting on the lid? Ignore the friction due to the walls of the tube.

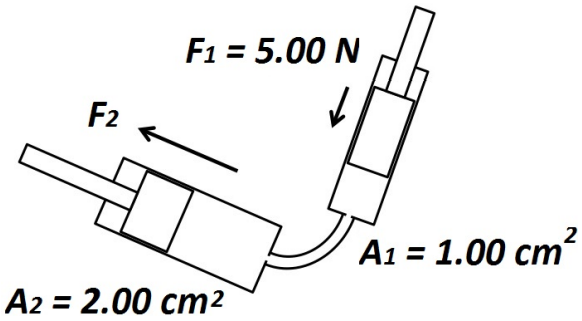



A. $7.85\,\mathrm{N}$, downward
B. $18.7\,\mathrm{NN}$, upward
C. $20.6\,\mathrm{N}$, downward
D. $44.2\,\mathrm{N}$, upward

18. **Mystery fluid.** A $30.0\text{-m}$ tall open tank is half-filled with water, then filled to the brim with a mystery fluid of density $690.\,\mathrm{kg/m^3}$ that sits on top of the water. What is the absolute pressure at the bottom of the tank? ($P_{atm} = 1.01 \times 10^5\,\mathrm{Pa}$, $\rho_{water} = 1.00 \times 10^3\,\mathrm{kg/m^3}$)

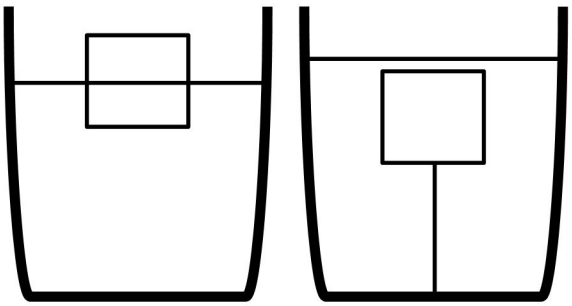
A. $350.\,\mathrm{kPa}$ B. $699\,\mathrm{kPa}$ C. $497\,\mathrm{kPa}$ D. $249\,\mathrm{kPa}$

19. **Hydraulic Arm.** A robotic hydraulic arm is powered by a piston chamber with cross-sectional area of $2.00\,\mathrm{cm^2}$ connected to a longer but thinner piston chamber with cross-sectional area of $1.00\,\mathrm{cm^2}$. If a 5.00 N-force can be applied on the longer piston chamber, how much force can the robotic hydraulic arm exert?



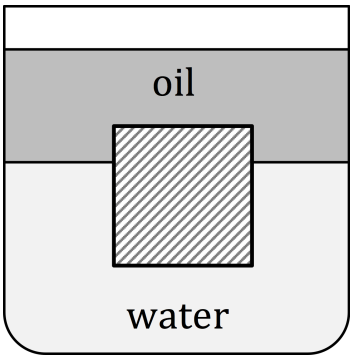

A. 20.0 N B. 10.0 N C. 2.50 N D. 1.25 N

20. **Anchored.** A cubical box with side length of $0.520\,\mathrm{m}$ floats in water with half of its height submerged. A string is used to anchor the box so that it is fully submerged as shown. What is the tension in the string? $\rho_{water} = 1.00 \times 10^3\,\mathrm{kg/m^3}$



A. $2070\,\mathrm{N}$
B. $1380\,\mathrm{N}$
C. $689\,\mathrm{N}$
D. $172\,\mathrm{N}$

21. **Cube of the Unknown.** A cubical block made of some unknown material is at rest and fully submerged in a mixture of oil ($\rho_{\text{oil}} = 8.00 \times 10^2\,\text{kg/m}^3$) and water ($\rho_{\text{water}} = 1.00 \times 10^3\,\text{kg/m}^3$). One fourth of the block is in oil and the rest is in water. What is the density of the block?




A. $850\,\text{kg/m}^3$
B. $900\,\text{kg/m}^3$
C. $950\,\text{kg/m}^3$
D. $1000\,\text{kg/m}^3$

22. **Flow Rida.** An incompressible fluid flows out of a cylindrical tube with diameter $5.0\,\text{cm}$ at a volume flow rate of $5.0\,\text{cm}^3/\text{s}$. What is the speed of the fluid as it flows out of the tube?

A. $0.25\,\text{cm/s}$ B. $0.064\,\text{cm/s}$ C. $0.32\,\text{cm/s}$ D. $0.16\,\text{cm/s}$

23. **Airplane.** Which of the following statement/s is/are true about airplane lift?

I. The upward lift is due to the difference in pressure above and below the wing of the airplane
II. The pressure above the wing is lower than the pressure below it.
III. The air above the wing moves slower than the air below it.

A. I only
B. I and II only
C. I and III only
D. all of the above

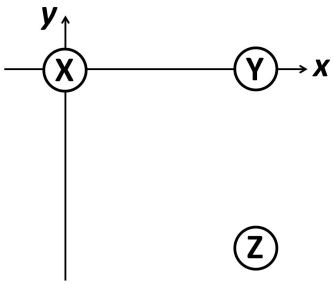
24. **Wattaah!!! - Bruce Lee.** A water pipe located at the top of the $15.0\,\text{m}$ tall dojo owned by Bruce Lee has a diameter of $6.00 \times 10^{-2}\,\text{m}$. It is connected to the exhaust pipe (diameter of $3.00 \times 10^{-2}\,\text{m}$) with pressure reading of $1.00\times 10^5\,\text{Pa}$ and is located $3.00\,\text{m}$ above the ground. If the velocity of the water at the exhaust pipe is $10.0\,\text{m/s}$, what is the water pressure at the top of the dojo? The density of water is $\rho_{water} = 1.00 \times 10^3\,\text{kg/m}^3$

A. $2.93 \times 10^4\,\text{Pa}$
B. $1.99 \times 10^4\,\text{Pa}$
C. $3.30 \times 10^5\,\text{Pa}$
D. $3.23 \times 10^4\,\text{Pa}$

25. **Diwata-1.** The recently launched Philippine microsatellite has a weight of $w$ on the Earth's surface. What is the weight of the microsatellite if it reaches a distance that is twice the radius of the Earth from Earth's surface.

A. $w/9$ B. $w/3$ C. $9w$ D. $3w$

26. **Gravity Triples.** Particles X, Y and Z, each with mass $m$, are located at $(0, 0)$, $(+20d, 0)$ and $(+20d, -21d)$ respectively, where $d > 0$. What is the net gravitational force on **particle Y**?




A. $\dfrac{Gm^2}{d^2}\left[-\dfrac{1}{400}\hat{\imath} - \dfrac{1}{441}\hat{\jmath}\right]$ C. $\dfrac{Gm^2}{d^2}\left[+\dfrac{1}{400}\hat{\imath} - \dfrac{1}{441}\hat{\jmath}\right]$

B. $\dfrac{Gm^2}{d}\left[-\dfrac{1}{20}\hat{\imath} - \dfrac{1}{21}\hat{\jmath}\right]$ D. $\dfrac{Gm^2}{d}\left[+\dfrac{1}{20}\hat{\imath} - \dfrac{1}{21}\hat{\jmath}\right]$

27. **Project Tiles.** Two projectiles were launched from the surface of the Earth. Projectile A reached a maximum height equal to the Earth's radius while projectile B reached a maximum height equal to twice the earth's radius, both measured from the surface of the earth. What is the ratio of the initial speed $v_A/v_B$?

A. $\dfrac{\sqrt{3}}{2}$ B. $\sqrt{3}$ C. $\dfrac{2}{\sqrt{3}}$ D. $\dfrac{4}{3}$

28. **Planet X.** Suppose Planet X has mass twice as large as that of the Earth's, but has the same radius as that of the Earth. If the escape speed on Earth's surface is $v$, what is the escape speed on Planet X's surface?

A. $2v$ C. $v/2$

B. $\sqrt{2}v$ D. $v/\sqrt{2}$

29. **Home of the Nameks.** A satellite of mass $m$ is sent to Planet Namek with mass $M_N$ and radius $R_N$. If the satellite moves around a circular orbit with distance $h$ from the surface of Namek, what is the satellite's orbital speed?

A. $\sqrt{\dfrac{GM_N}{R_N + h}}$ B. $\sqrt{2\dfrac{GM_N}{R_N}}$ C. $\sqrt{2\dfrac{Gm}{R_N}}$ D. $\sqrt{\dfrac{Gm}{R_N + h}}$

30. **Kepler-kun.** Which of the following statements are **TRUE** according to Kepler's Laws?

I. Each planets move in an elliptical orbit, with the sun at one focus of the ellipse.

II. A line from the sun to the planets sweeps out equal areas in equal times.

III. The periods of the planets are proportional to the $2/3$ powers of the major axis lengths of their orbits.

A. I and II B. II and III C. I and III D. I, II and III

31. **Planet Momonja.** An exoplanet revolves around a star with the same mass as our sun ($m_s = 1.99 \times 10^{30}\,\mathrm{kg}$). Its distance at aphelion and at perihelion are $5.67 \times 10^{11}\,\mathrm{m}$ and $9.90 \times 10^{8}\,\mathrm{m}$, respectively. What is the exoplanet's orbital period? $G = 6.67 \times 10^{-11}\,\mathrm{N \cdot m^2/kg^2}$

A. $6.01 \times 10^{3}\,\mathrm{seconds}$
B. $2.33 \times 10^{8}\,\mathrm{seconds}$
C. $8.25 \times 10^{7}\,\mathrm{seconds}$
D. $1.70 \times 10^{4}\,\mathrm{seconds}$

32. **SimpleLang.** Which one of the following statements is true concerning an object undergoing simple harmonic motion?

A. Its velocity is never zero.

B. Its acceleration is never zero.

C. Its velocity is zero when its acceleration is zero.

D. Its velocity is zero when its acceleration is a maximum.

*The velocity of a certain spring-mass system in simple harmonic motion is given by*

$$v_x(t) = (-12.0\,\mathrm{m/s})\sin[(6.00\,\mathrm{rad/s})t].$$

33. **Maximum displacement.** What is the maximum displacement of the oscillator from the equilibrium position?

A. $0.500\,\mathrm{m}$ B. $2.00\,\mathrm{m}$ C. $12.0\,\mathrm{m}$ D. $72.0\,\mathrm{m}$

34. **Springiness.** If the mass of the oscillator is $4.20\,\mathrm{kg}$, what is the spring constant?

A. $1.20\,\mathrm{N/m}$ B. $12.3\,\mathrm{N/m}$ C. $25.2\,\mathrm{N/m}$ D. $151\,\mathrm{N/m}$

35. **Block voting.** A block of mass $5.00\,\mathrm{kg}$ attached to a horizontal spring with force constant $100.\,\mathrm{N/m}$ is moving in simple harmonic motion. When the block is $2.00\,\mathrm{m}$ away from its equilibrium position, its speed is $2.00\,\mathrm{m/s}$. What is the amplitude of oscillation?

A. zero B. $1.48\,\mathrm{m}$ C. $2.05\,\mathrm{m}$ D. $2.86\,\mathrm{m}$

36. **Oh si late!** A mass oscillates with amplitude $A$ at the end of a spring. How far is the mass from the equilibrium position of the spring when the potential energy is four times the kinetic energy?

A. $\frac{\sqrt{5}}{2}A$ B. $\frac{2}{\sqrt{5}}A$ C. $\frac{1}{\sqrt{5}}A$ D. $\frac{1}{2}A$

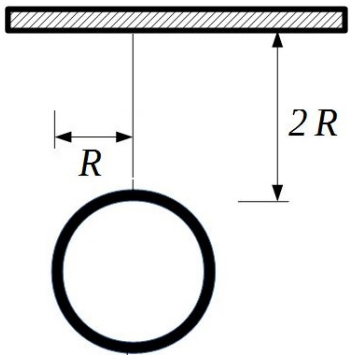
37. **Batang may Laban.** A box of Bonakid with mass $45\,\mathrm{kg}$ is attached on a lightweight vertical spring with constant $k = 550\,\mathrm{N/m}$. The spring stretches by $80.\,\mathrm{cm}$ as it reaches the equilibrium state. If it is pulled down by another $10.\,\mathrm{cm}$ then released, what will be the angular frequency of the oscillation?

A. $0.56\,\mathrm{rad/s}$ B. $1.1\,\mathrm{rad/s}$ C. $1.8\,\mathrm{rad/s}$ D. $3.5\,\mathrm{rad/s}$

38. **Martian.** The Martian prepares for another Mars expedition and this time, he brings a 0.200 -m simple pendulum along with him. How many full cycles did the pendulum make in $125\,\mathrm{s}$ if $g = 3.73\,\mathrm{m/s^2}$ on Mars?

A. 42 B. 86 C. 181 D. 192

39. **Ring on a string.** A light string of length $2R$ is used to hang a uniform ring of radius $R$ and mass $M$ as shown. If the ring is displaced by a small angle with respect to the vertical, what is the angular frequency of the ring's oscillation? The moment of inertia of the ring about its center of mass is $I_{cm} = MR^2$.




A. $\sqrt{\frac{g}{3R}}$ C. $\sqrt{\frac{4}{17}\frac{g}{R}}$

B. $\sqrt{\frac{2}{5}\frac{g}{R}}$ D. $\sqrt{\frac{3}{10}\frac{g}{R}}$

40. **It's over!** Which of the following is TRUE for an overdamped oscillator?

I. It oscillates with a steadily decreasing frequency.
II. It returns to its equilibrium position without oscillation.
III. Its damping force is nonconservative.

A. I only B. I and II C. II and III D. I and III