College Physics 1 Midterm 2

PHYS 1511

11/04/2016

Professor Halekas

Form A

(Put this letter on your scantron!)

Directions for completing your answer sheet

1. Use a no. 2 or softer **PENCIL**. Marks should be dark and completely fill each circle. Carefully erase any marks you want to change. Do not make any stray marks on your answer sheet.

2. Print your name in the appropriate boxes and darken the corresponding circles.

3. Record all 8 digits of your University ID number starting in box A under "**ID NUMBER**" and darken the corresponding circles. **Be sure you start in box A.**

4. Note the letter following the word **FORM** in the box at the top of this page and darken the corresponding letter in the **TEST FORM** area of your answer sheet.

5. Mark only one response for each test item.

FAILURE TO FOLLOW THE ABOVE DIRECTIONS COULD RESULT IN AN INCORRECT SCORE

Read the following and provide your signature:

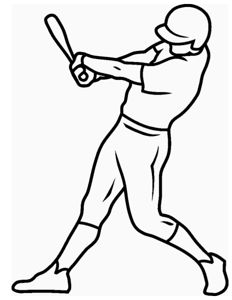
I understand that sharing information with anyone during this exam by talking, looking at someone else's test, or any other form of communication, will be interpreted as evidence of cheating. I also understand that if I am caught cheating, the result will be no credit (0 points) for this test, and disciplinary action may result.

Signature: ____

Print your name: ______________________________________

(This will help identify your test paper in the event of any scoring issues)

Question 1: Kyle Hendricks throws a strike with a velocity of 40 m/s. Carlos Santana hits the ball solidly and it travels straight back towards the pitcher at 80 m/s. Assuming the ball has a mass of 0.1 kg and the bat was in contact with the ball for 0.1 s, what was the magnitude of the force exerted by the bat on the ball during contact?



A. 40 N
B. 80 N
C. 12 N
D. 120 N
E. 4 N

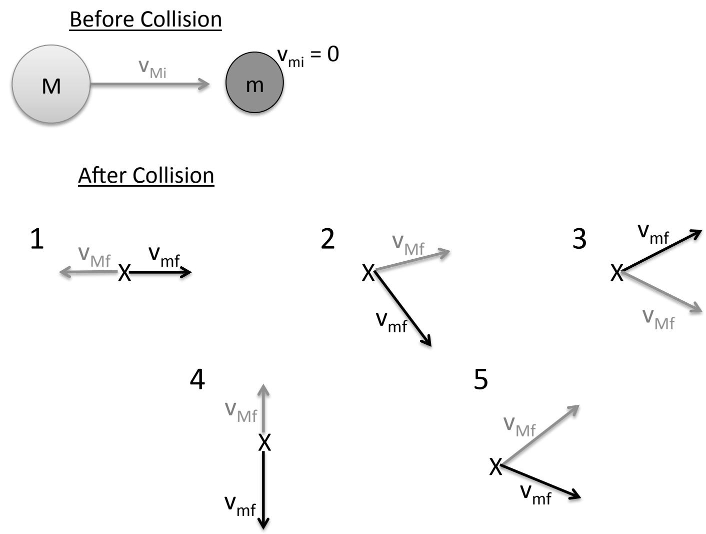
Question 2: Ashley is riding in a shopping cart across a parking lot. Together, Ashley and the cart have a mass of 80 kg, and they are traveling at 3 m/s. As the cart passes Bill, a 40 kg boy, he jumps onto the cart (from a standing position, with zero initial velocity). What is the velocity of the cart immediately afterward?

A. 3 m/s
B. 4 m/s
C. 2 m/s
D. 1 m/s
E. 1.5 m/s

Question 3: Fred is standing on a boat at rest in still water. Fred has a mass of 100 kg and the boat has a mass of 50 kg. Fred takes a running leap and jumps off of the boat with a velocity v_{xFf} of +5 m/s. What is the magnitude and sign of the velocity v_{xBf} of the boat in the X direction immediately afterward?

A. -5 m/s
B. -2 m/s
C. 0 m/s
D. -3.33 m/s
E. -10 m/s

Question 4: Two masses collide, with initial velocities as shown. Assuming M > m, and no net external forces, which of the following set of final velocities could be correct? Assume all velocity vectors are to scale.



A. 1
B. 2
C. 3
D. 4
E. 5

Question 5: A wheel initially at rest undergoes a uniform angular acceleration of 4 rad/s^2 for a 10 s time interval. What is the total angular displacement of the wheel in this time?

A. 40 rad
B. 20 rad
C. 300 rad
D. 200 rad
E. 400 rad

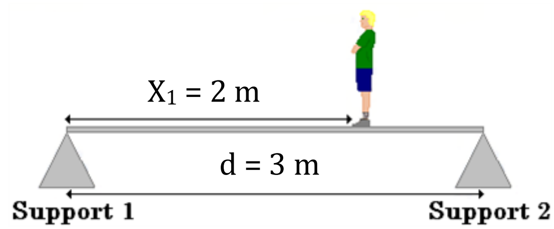
Question 6: A bicycle with wheels of 0.1 m radius travels 100 m along a path, its wheels rolling without slipping for the entire distance. What is the total angular displacement of each wheel during this trip?

A. 10 rad
B. 200 π rad
C. 100 rad
D. 1,000 rad
E. 100 π rad

Question 7: A wheel with an initial angular velocity of 10 rad/s and moment of inertia I = 2 kg m^2 is acted upon by a constant decelerating torque. Assuming that the wheel undergoes an angular displacement of 10 radians before coming to a stop, what is the magnitude of the torque?

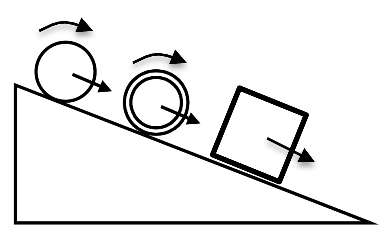
A. 1 N m
B. 2 N m
C. 5 N m
D. 10 N m
E. 100 N m

Question 8: Melissa, who has a mass of 90 kg, stands on a massless plank between two supports that are 3 m apart. As shown in the figure at right, she stands 2 m from Support 1 and 1 m from Support 2. How large is the normal force exerted on the plank by Support 1? Assume g = 10 m/s^2.



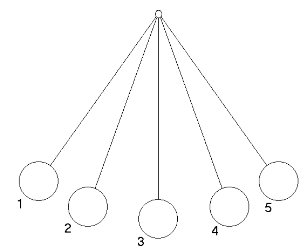
A. 300 N
B. 600 N
C. 900 N
D. 30 N
E. 60 N

Question 9: Three objects roll or slide down a ramp under the influence of gravity, all of them with the same mass, and all starting from rest at the top of the ramp at the same time. The disk and the hoop roll without slipping. The box slides with no friction. What is the order of their finish at the bottom (winner first)?



A. Hoop, disk, box
B. Box, disk, hoop
C. Disk, hoop, box
D. Box, hoop, disk
E. Disk, box, hoop

Question 10: A simple pendulum consisting of a mass M on the end of a string swings with amplitude A_1. At the maximum displacement from equilibrium (point 1 or 5 in figure at right) of the swing, a second mass M is added to the end of the string, giving the pendulum a total mass of 2M. What is the amplitude A_2 of the subsequent harmonic motion?

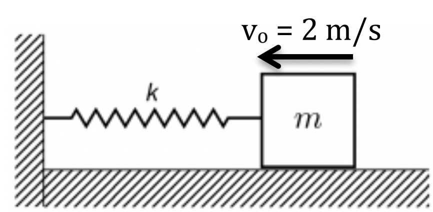


A. $A_2 = 2A_1$
B. $A_2 = \sqrt{2}A_1$
C. $A_2 = A_1$
D. $A_2 = A_1/\sqrt{2}$
E. $A_2 = A_1/2$

Question 11: A mass m on a spring with spring constant k is in harmonic motion. As the mass passes through the equilibrium point, the spring is suddenly made stiffer (the spring constant k is increased) without changing the mass or the instantaneous velocity of the mass at that point. What happens to the amplitude and frequency of the subsequent harmonic motion?

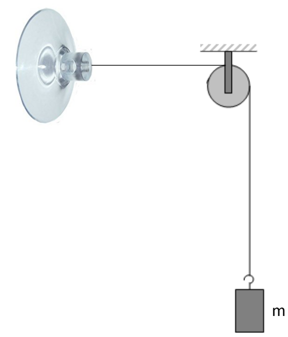
A. Amplitude increases, frequency increases
B. Amplitude decreases, frequency increases
C. Amplitude stays the same, frequency increases
D. Amplitude increases, frequency decreases
E. Amplitude decreases, frequency decreases

Question 12: A mass m = 2 kg is set oscillating on a spring with spring constant k = 8 N/m by giving it an initial velocity of 2 m/s, with the spring initially un-stretched (at equilibrium). What is the magnitude of the maximum force exerted on the mass by the spring during the subsequent harmonic motion?



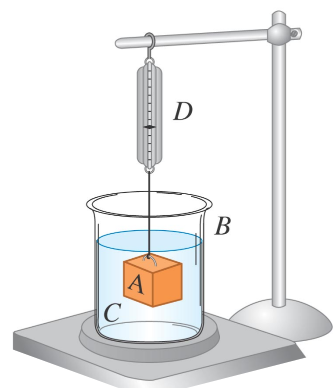
A. 0.5 N
B. 1 N
C. 2 N
D. 4 N
E. 8 N

Question 13: A suction cup with area 0.01 m^2 is pressed firmly onto a window. A force is applied to pull the suction cup straight out from the window by hanging a mass from a pulley, as shown in the figure at the right. Assuming perfect suction, how big would the mass have to be to pull the suction cup off of the window? Assume atmospheric pressure $P_{atm} = 10^5$ Pa and $g = 10$ m/s^2.



A. 10^{-2} kg
B. 10^4 kg
C. 10^2 kg
D. 10^3 kg
E. 10^5 kg

Question 14: Block A, which has a mass of 2 kg and a mass density twice that of water, is suspended from a spring scale (D), which initially registers a weight of 20 N in air. When the block is suspended in the beaker of water B (not touching the bottom), what is the new reading on the spring scale? Assume $g = 10$ m/s^2.



A. 0 N
B. 5 N
C. 10 N
D. 20 N
E. 40 N

Question 15: To what depth D do you have to dive in a lake to double the total pressure exerted upon your body? Assume atmospheric pressure $P_{atm} = 10^5$ Pa, $g = 10$ m/s^2, and the density of water $\rho = 1000$ kg/m^3.

A. D = 1 m
B. D = 10 m
C. D = 100 m
D. D = 1,000 m
E. D = 10,000 m

Trigonometry (*For right triangle with sides Adjacent, Opposite, and Hypoteneuse*):

Sin(θ) = O/H *Cos(θ) = A/H* *Tan(θ) = O/A* *H² = O² + A²* $A_{circle} = \pi r^2$

Sin(30°) = Cos(60°) = ½ *Sin(60°) = Cos(30°) =√3/2 ~=0.866* *Sin(45°) = Cos(45°) = √2/2 ~0.707*

Sin(0°) = Cos(90°) = 0 *Sin(90°) = Cos(0°) = 1*

Moment of Inertia

Point mass or thin-walled wheel: $I = mr^2$ *Solid cylinder:* $I = \frac{1}{2} mr^2$

Thin rod pivoting around end: $I = 1/3\ mr^2$ *Solid sphere:* $I = 2/5\ mr^2$

Kinematics:

$\langle\vec{v}\rangle = \frac{\Delta\vec{r}}{\Delta t}$ $\langle\vec{a}\rangle = \frac{\Delta\vec{v}}{\Delta t}$ $\vec{r}(t) = \vec{r_0} + \vec{v_o}t + \frac{1}{2}\vec{a}t^2$ $v(t)^2 = {v_o}^2 + 2\vec{a}\cdot\Delta\vec{r}(t)$

Newton's Laws:

$\sum\vec{F} = m\vec{a}$ $\vec{F_{AB}} = -\vec{F_{BA}}$

Forces:

$F_G = mg$ (@ surface) ${f_s}^{MAX} = \mu_s F_N$ $f_k = \mu_k F_N$

$F_C = ma_c = \frac{mv^2}{r}$ $F_{spring} = -kx$ $F_{Buoyant} = m_{fluid\_displaced}\ g$

Work & Energy:

$KE_{trans} = \frac{1}{2}mv^2$ $\Delta KE = W_{net}$ $PE_G = mgh$ $PE_{spring} = \frac{1}{2}kx^2$

$E = KE + PE$ $\Delta E = W_{nc}$ $W = \vec{F}\cdot\Delta\vec{r} = |\vec{F}||\Delta\mathrm{\vec{r}}|\cos\theta_{Fdr}$

Impulse & Momentum:

$\vec{J} = \vec{F}\Delta t$ $\vec{p} = m\vec{v}$ $\sum\vec{J} = \Delta\vec{p}$ $\sum\vec{p_f} = \sum\vec{p_i}$ *(if F_{ext}=0)*

$\vec{v_{cm}} = \frac{\sum m_i\vec{v_i}}{\sum m_i} = \sum\vec{p}/M$

Rotational Motion:

$\theta = s/r$ $\langle\omega\rangle = \frac{\langle v_t\rangle}{r} = \frac{\Delta\theta}{\Delta t}$ $\langle\alpha\rangle = \frac{\langle a_t\rangle}{r} = \frac{\Delta\omega}{\Delta t}$

$\theta(t) = \theta_o + \omega_o t + \frac{1}{2}\alpha t^2$ $\omega(t)^2 = {\omega_o}^2 + 2\alpha\Delta\theta(t)$

$\tau = rF\sin\theta_{rF} = F * lever\ arm$ $\sum\tau = I\alpha$ $L = mvr = I\omega$

$W_{rot} = \tau\Delta\theta$ $KE_{rot} = \frac{1}{2}I\omega^2$ $r_{CM} = \frac{\sum m_i r_i}{\sum m_i}$

Harmonic Motion:

$\omega_h = 2\pi f_h = \frac{2\pi}{T} = \sqrt{\frac{k}{m}}$ $x_{max} = A$ $v_{max} = A\omega_h$ $a_{max} = A{\omega_h}^2$

$\omega_{h\_pendulum} = \sqrt{\frac{mgr_{CM}}{I}} = \sqrt{\frac{g}{L}}$ *for simple pendulum of length L*

Fluids:

$\rho = mass/Volume$ $P = F/A$ $P_2 = P_1 + \rho gd$ $F_B = W_{fluid\_displaced}$

$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$ $A_1 v_1 = A_2 v_2\ (if\ \rho_1 = \rho_2)$ $P_1 + \frac{1}{2}\rho {v_1}^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho {v_2}^2 + \rho g y_2$