Name ______________________ Date ____________

25Sept06
LeClair
FormA

PH 105-2 Exam I

1. Which of the following *could* be the proper equation for the energy of an object moving at relativistic velocities (*i.e.,* close to the speed of light)? Note that energy E has units of kg·m^2/s^2, the speed of light c is in m/s, mass m is in kg, and momentum p is in kg·m/s.

- ○ $E = pc + m^2c^2$
- ○ $E^2 = p^2c + (mc^2)^2$
- ○ $E = p^2c^2 + (mc^2)^2$
- ○ $E^2 = p^2c^2 + (mc^2)^2$

2. A car is traveling at a constant velocity of 18 m/s and passes a police cruiser. Exactly 2 seconds after passing, the cruiser begins pursuit, with a constant acceleration of 2.5 m/s^2. How long does it take for the cruiser to overtake the car (from the moment the cop car starts)?

- ○ 16.2 sec
- ○ 13.2 sec
- ○ 24.3 sec
- ○ 0.22 sec

3. The position of a particle can be described by the equation $x(t) = 2.5 + 1.7t - 3.9t^2$. When the particle returns to its $t = 0$ position some time later, what is its velocity?

- ○ 1.7 m/s
- ○ -16.2 m/s
- ○ 2.5 m/s
- ○ -1.7 m/s

4. A rubber ball was thrown at a brick wall with an initial speed of 10 m/s, and rebounded in the opposite direction with a speed of -8.5 m/s. The rebound was found to take 3.5×10^{-3} sec. What was the acceleration experienced by the ball during the rebound?

- ○ -9.8 m/s^2
- ○ -5300 m/s^2
- ○ 480 m/s^2
- ○ 2600 m/s^2

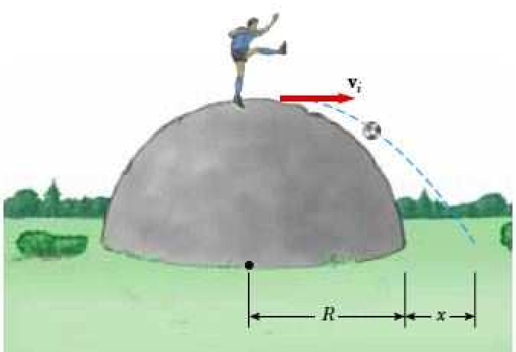
5. A projectile will be launched with an initial velocity of 750 m/s, and needs to hit a target 23 km away. What should the launch angle be? You can ignore air resistance.

- ◯ 12°
- ◯ 24°
- ◯ 7°
- ◯ 20°

6. Joe foolishly fires his .270 Winchester, which has a muzzle velocity of 957 m/s using a 130 grain load, into the air at a 17° angle. Ignoring air resistance, how far away from Joe will the bullet land?

- ◯ 2.7×10^4 m
- ◯ 5.2×10^4 m
- ◯ 1.1×10^4 m
- ◯ 9.8×10^3 m

7. A person standing at the top of a hemispherical rock of radius R kicks a ball (initially at rest on the top of the rock) to give it horizontal velocity $\vec{\mathbf{v}}_\mathbf{i}$ as shown below. What must be its minimum initial speed if the ball is never to hit the rock after it is kicked?

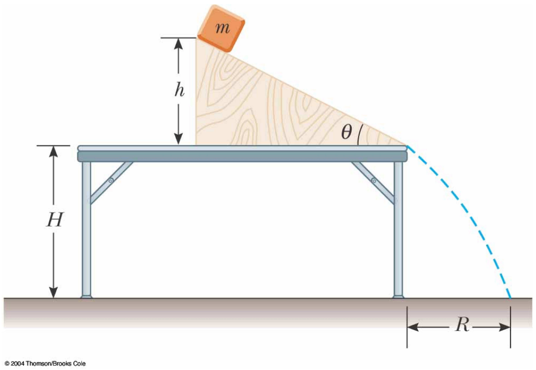


- ◯ $|\vec{\mathbf{v}}_\mathbf{i}| > gR$
- ◯ $|\vec{\mathbf{v}}_\mathbf{i}| > \sqrt{gR}$
- ◯ $|\vec{\mathbf{v}}_\mathbf{i}| > \sqrt{2gR}$
- ◯ $|\vec{\mathbf{v}}_\mathbf{i}| > R^2/g$

8. After being struck by a hockey stick, a hockey puck slides across the ice with an initial velocity of 7.0 m/s. If the coefficient of kinetic friction μ_k between the ice and the puck is 0.15, what is the velocity of the puck when it reaches the goal 10 m down the ice?

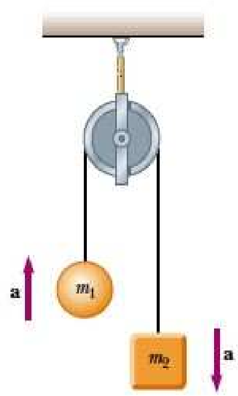
- ◯ 4.4 m/s
- ◯ it does not reach the goal, μ_k is too big
- ◯ 2.2 m/s
- ◯ 19.6 m/s

9. Consider the figure below. Let $h = 1\,\text{m}$, $\theta = 37°$, $H = 2\,\text{m}$, and $m = 1.1\,\text{kg}$. There is a coefficient of kinetic friction $\mu_k = 0.2$ between the mass and the inclined plane, and the mass m starts out at the very top of the incline with a velocity of $0.1\,\text{m/s}$. Ignoring air resistance, what is R?



- ◯ 4.0 m
- ◯ 0.5 m
- ◯ 2.6 m
- ◯ 1.4 m

10. Consider the so-called "Atwood's machine" below. What is the acceleration of the two masses, if one ignores friction and the mass of the pulley and rope?

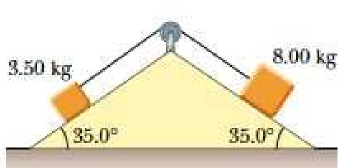


- ◯ $|\vec{\mathbf{a}}| = \left(\frac{m_2+m_1}{m_2-m_1}\right) g$
- ◯ $|\vec{\mathbf{a}}| = (m_2 - m_1)\, g$
- ◯ $|\vec{\mathbf{a}}| = \left(\frac{m_2-m_1}{m_1+m_2}\right) g$
- ◯ $|\vec{\mathbf{a}}| = \left(\frac{m_2-m_1}{m_2}\right) g$

11. A block with mass 5 kg has an initial velocity of $\vec{\mathbf{v}}_\mathbf{i} = (7.0\,\hat{\mathbf{i}} + 3.1\,\hat{\mathbf{j}})\,\text{m/s}$ on a surface with no friction. A force acts on the block, and 17 seconds later its velocity is $\vec{\mathbf{v}}_\mathbf{f} = (2.0\,\hat{\mathbf{i}} + 15\,\hat{\mathbf{j}})\,\text{m/s}$. What was the magnitude of the force that caused the change in velocity?

- ◯ 3.8 N
- ◯ 5.5 N
- ◯ 14 N
- ◯ 4.4 N

12. Two blocks of mass 3.50 kg and 8.00 kg are connected by a massless string that passes over a frictionless pulley, as shown in the figure below. The inclines are frictionless. Find the tension in the string. (*Hint: do you expect the blocks to be moving?*)

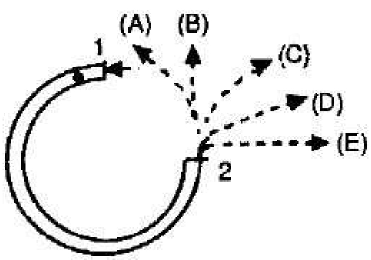


- ◯ 110 N
- ◯ 27 N
- ◯ 12 N
- ◯ 64 N

13. A 1500 kg car moving on a flat, horizontal road negotiates a curve. If the radius of the curve is 35.0 m and the coefficient of static friction between the tires and dry pavement is $\mu_s = 0.500$, find the maximum speed the car can have and still make the turn successfully. (*Hint: what is balancing the force of friction?*)

- ◯ 13.1 m/s
- ◯ 27.4 m/s
- ◯ 18.5 m/s
- ◯ 6.5 m/s

14. The diagram below depicts a semicurcular channel that has been securely attached, in a **horizontal plane**, to the table top. A ball enters at channel "1", and exits at "2". Which of the path representations would most nearly correspond to the path of the ball as it exits the channel at "2" and rolls across the table top?

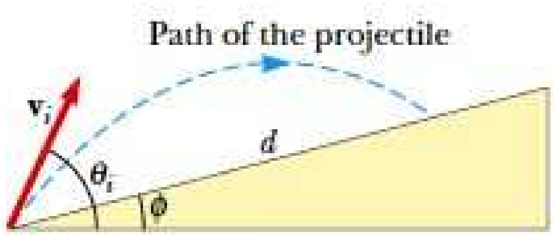


- ◯ A
- ◯ B
- ◯ C
- ◯ D
- ◯ E

15. Two metal balls are the same size, but one weights twice as much as the other. The balls are dropped from the top of a two story building at the same instant of time. The time it takes the balls to reach the ground below will be:

- ◯ about half as long for the heavier ball
- ◯ about half as long for the lighter ball
- ◯ about the same for both balls
- ◯ considerably less for the heavier ball, but not necessarily half as long
- ◯ considerably less for the lighter ball, but not necessarily half as long

BONUS 1 (+1pt): A projectile is fired up an incline (incline angle φ) with an initial speed v_i at an angle θ_i with respect to the horizontal ($\theta_i > \varphi$), as shown in the figure below. How far up the incline does the projectile land?



BONUS 2 (+1pt): You push an object, initially at rest, across a frictionless floor with a constant force for a time interval t, resulting in a final speed of v for the object. You repeat the experiment, but with a force that is twice as large. What time interval is now required to reach the same final speed v?

- ◯ $4t$
- ◯ $2t$
- ◯ t
- ◯ $t/2$
- ◯ $t/4$

Some useful formulas

knowing the formula is not the same as knowing how and when to use it

Numbers

$g = 9.81\,\mathrm{m/s^2}$

1-D motion

$x_f = x_i + v_{xi}t + \frac{1}{2}a_x t^2$ $\qquad v_{xf}^2 = v_{xi}^2 + 2a_x\Delta x$ $\qquad v_f = v_i + at$

$v(t) = \frac{\mathrm{d}}{\mathrm{d}t}x(t)$ $\qquad a(t) = \frac{\mathrm{d}}{\mathrm{d}t}v(t) = \frac{\mathrm{d}^2}{\mathrm{d}t^2}x(t)$ $\qquad \overline{a} = \frac{\Delta v}{\Delta t}$ $\qquad \overline{v} = \frac{\Delta x}{\Delta t}$

2-D motion

$\vec{\mathbf{r}} = x(t)\,\hat{\mathbf{i}} + y(t)\,\hat{\mathbf{j}}$ $\qquad x(t) = x_i + v_{ix}t + \frac{1}{2}a_x t^2$ $\qquad y(t) = y_i + v_{iy}t + \frac{1}{2}a_y t^2$

$\vec{\mathbf{v}} = v_x(t)\,\hat{\mathbf{i}} + v_y(t)\,\hat{\mathbf{j}}$ $\qquad v_x(t) = v_{xi} + a_x t$ $\qquad v_y(t) = v_{yi} + a_y t$

Projectile motion

$v_x(t) = v_i\cos\theta$ $\qquad v_y(t) = v_i\sin\theta - gt$ $\qquad x(t) = x_i - v_x t$ $\qquad y(t) = y_i + v_{yi}t - \frac{1}{2}gt^2$

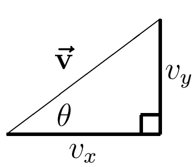
over level ground: max height $= H = \frac{v_i^2\sin^2\theta_i}{2g}$ $\qquad$ Range $= R = \frac{v_i^2\sin 2\theta_i}{g}$

$|\vec{\mathbf{v}}_{\mathbf{i}}| = \sqrt{\frac{Rg}{\sin 2\theta}}$ $\qquad \theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$ $\qquad y(x) = (\tan\theta_i)\,x - \left(\frac{g}{2v_i^2\cos^2\theta_i}\right)x^2$

Force

$\Sigma\vec{\mathbf{F}} = m\vec{\mathbf{a}}$ $\quad\Rightarrow\quad \Sigma F_x = ma_x$ $\qquad \Sigma F_y = ma_y$

$f_k = \mu_k n$ $\qquad n =$ normal force



$v_y = |\vec{\mathbf{v}}|\sin\theta$

$v_y = |\vec{\mathbf{v}}|\cos\theta$

$\tan\theta = \frac{v_y}{v_x}$