Exam 1, vers. A - Physics 1110 – Fall 2016

NAME(print) ________________________________

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Circle the DAY of your recitation:  WED  THU

Circle the START TIME of your recitation:  8am  9am  10am  11am  Noon  1pm  2pm  3pm  4pm  5pm

Please do not open the exam until you are told to.

Your exam should have 10 pages, numbered 1 thru 10. The last sheet is for scratch paper. This exam consists of 25 questions, worth 4 points each for a total of 100 points. Fill in the bubble sheet with a #2 pencil.

Please fill out your bubble sheet according to the following instructions or you may be penalized. Check each box as you complete the instructions.

☐ Please circle your TA's name and the day and start time of your recitation section.

☐ Print and bubble in your name on the bubble sheet.

☐ Print and bubble in your student Identification Number.

☐ Bubble in your Exam version, A or B, on your bubble sheet

☐ On your bubble sheet, erase mistakes thoroughly, and make no extraneous marks

☐ As you take the exam, show all your work on the exam and circle the correct answers on your exam. Your circled exam answers and bubbled answers must agree.

I have read and followed the instructions above. I give my word that I have neither given nor received unauthorized assistance on this exam.

Signature ________________________________

Possibly useful information: magnitude of acceleration of gravity on earth = \( g = +9.8 \text{ m/s}^2 \)
1. The mass per area of a certain kind of tile is 1 g/cm² (grams per centimeter-squared). What is the tile's mass per area in kg/m² (kilograms per meter-squared)?

A) 0.1  B) 1  C) 10  D) 100  E) None of these

\[
1 \text{ g/cm}^2 \times \frac{1 \text{ kg}}{1000 \text{ g}} \times \left(\frac{100 \text{ cm}}{1 \text{ m}}\right)^2 = \frac{10^4}{10^3} = 10 \text{ kg/m}^2
\]

2. A car traveling in a straight line, in the positive x-direction, has initial velocity \( v_0 \) and then slows down with constant acceleration of magnitude \( |a| \). While braking to a stop, the car travels a total distance of \( d \) in a time \( t \). Which one of the following formulas gives the stopping distance \( d \)?

A) \( \sqrt{2|a|v_0} \)  B) \( \frac{2|a|}{v_0^2} \)  C) \( v_0 t \)  D) \( \frac{v_0^2}{2|a|} \)  E) None of these

\[
\dot{v}^2 = v_0^2 + 2 a \cdot d
\]

3. A radio-controlled car races across a flat plain, with position vector given by

\[ \mathbf{r} = (-2 \cdot t^2 + 5 \cdot t + 5) \hat{i} + 3 \cdot t \hat{j} \]

where \( t \) is the time in seconds and units on the numbers are such that the resulting position components are in meters. To 3-place precision, what is the speed of the rover at \( t = 2 \text{ s} \)?

A) 3.46 m/s  B) 3.16 m/s  C) 4.24 m/s  D) 4.61 m/s  E) None of these

\[
\mathbf{v} = (-4 \cdot t + 5) \hat{i} + 3 \hat{j}
\]

\[
|\mathbf{v}| = \sqrt{(-4 \cdot 2 + 5)^2 + 3^2} = 3 \sqrt{2} = 4.24 \text{ m/s}
\]
The following three questions refer to this situation: Two carts, labeled A and B, travel along different, parallel straight tracks. Their velocities vs. time are shown in the graph.

4. At time \( t = 10 \) s, what is the magnitude of the acceleration of cart A?
   
   A) \( 5 \text{ m/s}^2 \)  
   B) \( 0 \text{ m/s}^2 \)  
   C) \( 0.2 \text{ m/s}^2 \)  
   D) \( 20 \text{ m/s}^2 \)  
   E) None of these.

   \[ |\alpha| = \left| \frac{\Delta v}{\Delta t} \right| \]

5. Which one of the following statements must be true about the net force on cart B at time \( t = 10 \) s?
   
   A) At \( t = 10 \) s, the net force on cart B is zero and the force is changing from the negative direction to the positive direction.  
   B) The net force is zero and its direction is changing from the positive direction to the negative direction.  
   C) The net force is zero and it is zero before and after \( t = 10 \) s.  
   D) The net force is non-zero and is in the positive direction.  
   E) The net force is non-zero and is in the negative direction.

6. Which one of the following statements must be correct?
   
   A) The two carts will pass (that is, they will have the same x-coordinate) at some time before \( t = 10 \) s.  
   B) The two carts will pass at \( t = 10 \) s.  
   C) The two carts will never pass.  
   D) There is not enough information given by the graph to decide when, if ever, the carts will pass each other.

7. A rock, dropped from rest, falls a distance \( h \) in 4.0 seconds. How far will the rock fall 1 second after being dropped from rest? (Assume that air resistance is negligible.)

   A) \( 16h \)  
   B) \( h/16 \)  
   C) \( 4h \)  
   D) \( h/4 \)  
   E) None of these.

vers. A
8. A rock is launched at an angle $\theta$ above the horizontal with initial speed $v_0$. Upward is chosen as the positive $y$-direction. Which graph correctly shows the $x$-component (the horizontal component) of the rock's velocity vs. time during the time that the rock is in flight? (As usual, neglect air resistance.)

![Graphs A, B, C, D, and E with descriptions for question 8](https://koofers.com/files/exam-o7qul2hrjg/)

9. Two cannonballs are fired. Cannonball A is fired at an initial angle that is larger than that of cannonball B. Both cannonballs reach the same maximum height. Assume no air resistance. Consider the following two statements:

I. Both cannonballs are fired with the same initial speed.

II. Both cannonballs are in flight for the same length of time.

Which statements are true?

A) Both statements are true.
B) Neither statement is true.
C) Statement I is true and II is false.
D) Statement I is false and II is true.

10. Three vectors $\vec{X}$, $\vec{Y}$, and $\vec{Z}$ are shown.
Which one of the following vector equations correctly describes this diagram?

A) $\vec{X} + \vec{Y} + \vec{Z} = 0$
B) $\vec{X} = \vec{Y} + \vec{Z}$
C) $\vec{X} + \vec{Y} = \vec{Z}$
D) $\vec{X} + \vec{Z} = \vec{Y}$
E) None of the above equations are correct.

vers. A
11. An object moves along the x-axis with the velocity shown in the graph. What is the magnitude of the displacement of the object $|x - x_0|$ between $t = 3\ s$ (when its velocity is $v = +1\ m/s$) and $t = 5\ s$ (when it's velocity is $v = -1\ m/s$)?

A) 1.0 m  
B) 1.5 m  
C) 4.0 m  
D) 0 m  
E) None of these

12. A mass $m_1$ on a table is attached by a massless string to a second mass $m_2$ hanging from a pulley as shown. The table has a rough surface so there is a frictional force of magnitude $F_{\text{fric}}$ on mass $m_1$. Mass $m_1$ is observed to be sliding sideways at constant speed $v$. How does the magnitude of the tension $F_T$ in the string pulling on $m_1$ compare to the magnitude of the force of friction acting on the mass $m_1$? Neglect any air resistance.

A) $F_T > F_{\text{fric}}$  
B) $F_T < F_{\text{fric}}$  
C) $F_T = F_{\text{fric}}$  
D) Impossible to answer based on the information given

13. An object of mass $m$ sits on the floor of an elevator that is going down, and it is slowing with a constant acceleration of magnitude $a$. How does the magnitude of the normal force $N$ from the floor on the mass compare with the magnitude of the weight $W$ of the object?

A) $N = W$  
B) $N > W$  
C) $N < W$  
D) Impossible to tell from the information given.

vers. A
14. An object is moving counter-clockwise around an oval-shaped track. Its acceleration vector, which is always at right angles to the trajectory, is shown when the object is at three different positions, labeled 1, 2, 3. Which statement best describes the motion of the object?

A) The object moves with an increasing speed.
B) The object moves with a decreasing speed.
C) The object moves with a constant speed.
D) The object moves with constant velocity.
E) None of these statements could be true.

15. The velocity of an object undergoing a constant acceleration is shown at two different times. The velocity at the early time is \( \mathbf{v}_1 \), the velocity at the later time is \( \mathbf{v}_2 \). What is the direction of the acceleration?

(E) None of these. Some other direction or acceleration is zero.

16. Consider three vectors, \( \mathbf{\bar{A}} \), \( \mathbf{\bar{B}} \), and \( \mathbf{\bar{C}} \), all in the xy plane with components

\[(A_x, A_y) = (2, 1), \quad (B_x, B_y) = (2, 2), \quad \text{and} \quad (C_x, C_y) = (4, -1).\]

To the nearest degree, what is angle measured CCW (counter-clockwise) between the positive x-direction and the direction of the vector \( \mathbf{\bar{S}} = \mathbf{\bar{A}} + \mathbf{\bar{B}} - \mathbf{\bar{C}} \)?

A) \(45^\circ\) \(\text{ }\) B) \(90^\circ\) \(\text{ }\) C) \(135^\circ\) \(\text{ }\) D) \(180^\circ\) \(\text{ }\) E) None of these.

\[
\begin{align*}
S_x &= 2 + 2 - 4 = 0 \\
S_y &= 1 + 2 - (-1) = 4
\end{align*}
\]

vers. A
17. A box of mass $m$ is sitting on the floor of an elevator, which is accelerating downward with constant non-zero acceleration of magnitude $a$. The magnitude of the normal force exerted on the box by the floor is $N$. The magnitude of the normal force exerted on the floor by the box is $N'$ ("N-prime"). What is the correct relationship between $N$ and $N'$?

(A) $N' = N$  
(B) $N' = N + ma$  
(C) $N' = N + mg$

(D) $N' = N - mg$  
(E) $N' = ma + mg - N$

18. An object is acted on by the three forces shown in the diagram. No other forces act on the object. To the nearest 0.1 N, what is the magnitude of the net force acting on the object?

A) 7.0 N  
B) 2.8 N  
C) 1.4 N

D) 13.0 N  
E) None of these

\[ |F_{\text{net}}| = 2\sqrt{2} \]

19. The graph shows velocity vs. time for a train moving along a straight track. (Note this is $v$ vs. $t$, NOT $x$ vs. $t$.) The graph shows that the train is ...

A) speeding up all the time.
B) slowing down all the time.
C) speeding up initially, but then slows down.
D) slowing down initially, but then speeds up.
E) changing direction.

vers. A
20. An object of mass \( m \) sits on a bathroom scale which is on the floor of an elevator that is going down. The elevator is slowing down with a constant acceleration of magnitude \( a \). The bathroom scale measures the magnitude \( N \) of the normal force on the object from the surface of the scale. What is the correct expression for the magnitude of the acceleration of the object?

A) \( N - mg \)  
B) \( \frac{N}{m} \)  
(C) \( \frac{N}{m} - g \)  
D) \( \frac{N}{m} + g \)  
E) None of these is correct.

\[ N - mg = ma \]  
\[ a = \frac{N}{m} - g \]

21. A projectile of mass \( m \) is fired with initial speed \( v_0 \) at an angle \( \theta \) above the horizontal from an initial height \( h \) above the ground, as shown. Assume no air resistance.

What is the correct expression for \( |v_y| \), the magnitude of \( y \)-component of the velocity of the projectile, just before it hits the ground?

A) \( \sqrt{(v_0 \sin \theta)^2 - 2gh} \)  
B) \( \frac{(v_0 \sin \theta)^2}{\sqrt{2gh}} \)  

(C) \( \sqrt{2gh} \)  
D) \( \sqrt{v_0^2 - 2gh} \)  
E) None of these

\[ |v_y| = \sqrt{v_{0y}^2 + 2 \frac{\Delta y}{t} (y - y_0)} \]

\[ v_{0y} = v_0 \sin \Theta \]

\[ = \sqrt{(v_0 \sin \Theta)^2 + 2gh} \]

Because of typo, everyone gets this question correct.

vers. A
22. A glider initially at the bottom of a tilted frictionless air track is given a brief initial shove so that it glides up the track and then glides back down to the bottom of the track. The coordinate system has been chosen as shown, with the positive direction pointed down the track, and the origin \((x = 0)\) located at the middle of the track, halfway between the starting point and the highest point of the glider.

Which graphs correctly show position \(x\) vs. time \(t\) and velocity \(v\) vs. time \(t\)?

<table>
<thead>
<tr>
<th>position (x)</th>
<th>velocity (v)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) graph 6</td>
<td>graph 5</td>
</tr>
<tr>
<td>B) graph 3</td>
<td>graph 1</td>
</tr>
<tr>
<td>C) graph 2</td>
<td>graph 4</td>
</tr>
<tr>
<td>D) graph 4</td>
<td>graph 1</td>
</tr>
<tr>
<td>E) graph 4</td>
<td>graph 5</td>
</tr>
</tbody>
</table>

vers. A
23. A rocket in intergalactic space is initially moving with constant velocity $\vec{v}_0 = 10 \text{ m/s} \hat{i}$. A thruster on the rocket fires, giving the rocket an acceleration of $\vec{a} = 2 \text{ m/s}^2 \hat{j}$ for 4 seconds, and then the thruster shuts off. What is the final speed of the rocket (to the nearest 0.1 m/s)?
A) 18.0 m/s  (B) 12.8 m/s  (C) 2.0 m/s  (D) 16.5 m/s  (E) None of these.

$$
\begin{align*}
\vec{v}_x &= \text{const} = v_{0x} = 10 \text{ m/s} \\
\vec{v}_y &= v_{0y} + a_y \cdot t = 0 + 2 \cdot 4 = 8 \text{ m/s}
\end{align*}
$$

24. A rock is thrown straight upward and reaches a maximum height $y = h$ above the ground (the ground is taken to be at $y = 0$). The positive $y$-direction is chosen to be upward, as shown in the diagram. Assume no air resistance. What is the value of the $y$-component of rock’s acceleration, $a_y$, at the top of its trajectory ($y = h$)?
(A) 0  (B) $+g$  (C) $g/2$  (D) $-g/2$  (E) $-g$

25. Which corner (W,X,Y,Z) of the coded plan is the viewpoint for the isometric sketch below?

(A) W  (B) X  (C) Y  (D) Z