Exam 1 – Version 1

Comments:

* Do not spend too much time on any one problem!

* To receive full credit you must clearly show and explain your work!!!

* Numerical answers must include appropriate units.

* You are allowed to use a graphing calculator on this exam. You may NOT use a smartphone or any other device with internet capabilities.

* Turn in your equation sheet with your exam.

* If you need more space for calculations, several blank pages are included at the end of the exam.

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1. (1 points)

The figure below represents the velocity and acceleration vectors of a bumble bee at some instant in time during its flight as viewed from above (assume that both vectors lie in the plane of the paper). At the instant shown, which of the following statements best describe the bee's motion?

A. The bee is turning to its left and slowing down.
B. The bee is turning to its right and speeding up.
C. The bee is moving in a straight line with constant speed.
D. The bee is moving in a straight line and slowing down.
E. None of the above.

2. (1 points)

A crate is placed on a scale inside an elevator. When the scale reads an apparent weight that is greater than the crate's actual weight, which of the following could describe the motion of the elevator? (Circle ALL that apply.)

A. Moving upwards at constant speed.
B. Moving upwards while slowing down.
C. Moving downwards while slowing down.
D. Moving downwards while speeding up.
E. None of the above.
3. (4 points)

Given below is a graph of an object's velocity along the $x$-axis as a function of time. Qualitatively sketch the corresponding position-vs-time and acceleration-vs-time graphs. (Quantitative details are not important here.)
4. (4 points)

Shown below is a motion diagram of a ball rolling up an incline until it reaches its turning point (at instant $t_4$). Draw the ball's acceleration vector at each instant shown in the motion diagram. Draw your vectors with correct relative magnitudes. If the acceleration vanishes at any point, state that explicitly.
5. (6 points)

An object moves along the track shown in the top-view diagram below. The track is curved near points A and B, straight near point C, and curved near points D and E. The object starts from rest at point A and continues to speed up at a constant rate as it moves from point A to point E.

i. Draw arrows on the diagram to represent the direction of the acceleration of the object at points A, B, C, D, and E. If the acceleration is zero at a point, then state that explicitly.

ii. Is the magnitude of the acceleration at point B greater than, less than, or equal to the magnitude of the acceleration at point D? Explain.
6. (6 points)

A particle undergoes motion in a straight line with acceleration given by $At^2$, where $t$ is time, and $A = 0.0200 \text{ m/s}^4$. At time $t = 5.00 \text{ s}$, the particle is located at the origin, and is momentarily at rest.

(a) What is the particle's velocity at $t = 2.00 \text{ s}$?

(b) What is the particle's position at $t = 2.00 \text{ s}$?

(c) Is the particle speeding up, slowing down, or moving with constant speed at $t = 2.00 \text{ s}$? Explain your reasoning.
7. (6 points)

Consider the vector \( \vec{C} = \vec{A} - \vec{B} \), where \( \vec{A} = 3\hat{i} + 2\hat{j} \) and \( \vec{B} = 4\hat{i} - 3\hat{j} \).

(a) Sketch (and clearly label) vectors \( \vec{A} \), \( \vec{B} \), and \( \vec{C} \) in the space below.

(b) Calculate the magnitude of \( \vec{C} \).

(c) Calculate the angle that \( \vec{C} \) makes with the positive x-axis.
8. (10 points)

Blocks A, B, and C are being pushed across a frictionless table by a hand that exerts a constant horizontal force $\vec{F}$. Block A has mass $2M$, block B has mass $3M$, and block C has mass $M$.

(a) In the spaces below, draw separate free-body diagrams for each of the three blocks. Clearly label each force with a *unique* label.

<table>
<thead>
<tr>
<th>Free-body diagram for block A</th>
<th>Free-body diagram for block B</th>
<th>Free-body diagram for block C</th>
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(b) Identify any third law force pairs that appear in your diagrams by placing a small corresponding mark on each member of the pair (*e.g.*, mark each member of the first pair with a “x” and each member of the second pair with “xx”, and so on).

(c) Rank the magnitudes of the *horizontal* forces that appear in your free-body diagrams above.

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9. (10 points)

Alice throws a ball from a roof top. The ball leaves her hand with a speed of 34.0 m/s, at an angle of 20.0° above the horizontal. The ball travels a horizontal distance of 100.0 m before striking the level ground below.

If we ignore air resistance, what is the magnitude of the ball's velocity as it strikes the ground?

To receive full credit, you must clearly show and explain your work.
10. (10 points)

Two blocks connected by a massless, inextendible string, are pulled by a force $\vec{F}$. The horizontal surface is frictionless. The mass of block A is $m_A$, and the mass of block B is $m_B$. Find an expression for the magnitude of the tension in the string as the blocks are being pulled in this way. Your expression may only contain $m_A$, $m_B$, $F$ (the magnitude of the pulling force), and any known constants or pure numbers.

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BONUS (2 points)

If the blocks in the previous problem have an initial velocity to the left with magnitude $v_0$, find an expression for the stopping distance $D$ in terms of $m_A$, $m_B$, $F$, and $v_0$. 
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