Université d'Ottawa
Faculté des sciences
University of Ottawa
Faculty of Science

PHY1124–Fundamentals of physics for engineers, Winter 2015

In-class test I

Montpetit 202, February 12 10 :00. Duration : 80 minutes. Professor : Christian Gigault.

Answer all questions with a short explanation and give a detailed solution to the problem. The test is closed book, closed notes. Use the exam sheets for your solutions, both sides if required. Write your name and student number on all pages. A non-programmable, non-graphing calculator is allowed. (Number of pages : 3)

Name and student # :

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1. (1 point) Is it possible, in a projectile trajectory, that at one point the velocity and acceleration be perpendicular to each other ? If it is possible, is it always the case ?

2. (1 point) You notice the value on the odometer of your car before and a after a drive. Is the difference between the two numbers equal to you displacement ? Are there situations where they would be equal ?

3. (1 point) Can one drive on a curved highway without accelerating ?

4. (1 point) You go in straight line from point A to point B at constant speed 70 km/hr. Then you go the same distance in the same direction from point B to point C at constant speed 90 km/hr. Is you average speed from A to C 80 km/hr ?

5. (1 point) If an object is released from rest and is in free fall, what happens to its acceleration–it increases, decreases, or remain the same ? Ignore aire resistance.

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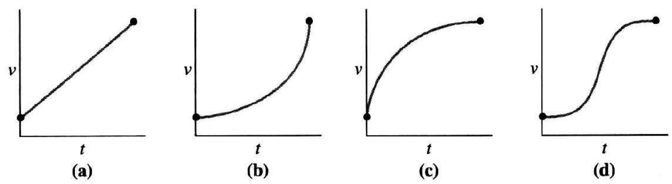
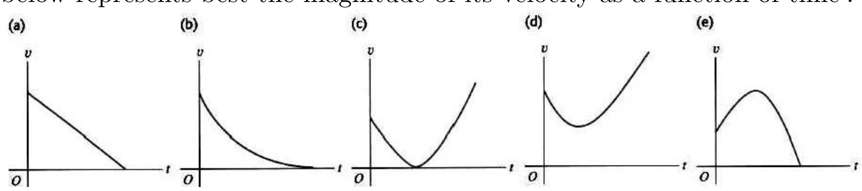
6. (1 point) Can the displacement vector for a particule moving in 2-D be longer than its trajectory during the same time interval ? Can it be shorter ?

7. (1 point) Among the velocity versus time graphs below, in which one(s) is the average velocity during the interval equal to the average of the initial and final velocities ?



8. (1 point) An airplane flies horizontally at 350 km/hr and loses a wheel. Neglecting air resistance, what is the trajectory of the wheel from the perspective of the pilot ? From the perspective of the control tower ?

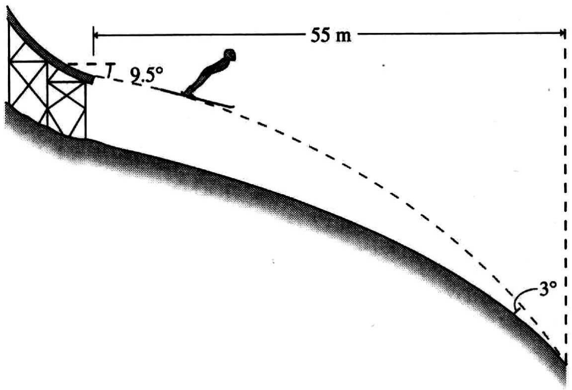
9. (1 point) A rock is thrown in a direction above horizontal and feels negligible air resistance. Which graph below represents best the magnitude of its velocity as a function of time ?



10. (1 point) Two canonballs are launched at à 50 m/s, one with with $\theta_A < 45°$ and the other with $\theta_B < 45°$ above horizontal, with $\theta_A > \theta_B$. Which one goes higher ? Which one stays in flight the longest time ? Which one goes further horizontally ?

Name and student # :

Problem (8 points) A well-designed ski jump is much less dangerous than it seems because skiers land with a velocity component perpendicular to the slope that is relatively small. In Lake Placid NY, skiers are launched at 28 m/s at an angle of 9.5° below horizontal, and landing happens at a horizontal distance 55 m from the launch. The slope in the landing zone is such that the skier's velocity just before landing is only at a 3° angle relative to the slope. What must be the angle of the slope in the landing zone?



1-D : $\Delta x = x_f - x_i \quad \Delta t = t_f - t_i \quad v_{x\,\text{avg}} = \frac{\Delta x}{\Delta t}$ $\quad v_x = \frac{dx}{dt} \quad a_{x\,\text{avg}} = \frac{\Delta v_x}{\Delta t} \quad a_x = \frac{dv_x}{dt} = \frac{d^2x}{dt^2}$

a_x constant : $v_{fx} = v_{ix} + a_x\Delta t \quad x_f = x_i + v_{ix}\Delta t + \frac{1}{2}a_x\Delta t^2 \quad v_{fx}^2 = v_{ix}^2 + 2a_x(x_f - x_i)$

3-D : $\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k} \quad \Delta\vec{r} = \vec{r} - \vec{r}_0$ $\quad \vec{v}_{\text{avg}} = \frac{\Delta\vec{r}}{\Delta t} \quad \vec{v} = \frac{d\vec{r}}{dt} \quad \vec{a}_{\text{avg}} = \frac{\Delta\vec{v}}{\Delta t} \quad \vec{a} = \frac{d\vec{v}}{dt} = \frac{d^2\vec{r}}{dt^2}$

$\vec{a}$ constant : $\vec{v}_f = \vec{v}_i + \vec{a}\Delta t \quad \vec{r}_f = \vec{r}_i + \vec{v}_i\Delta t + \frac{1}{2}\vec{a}\Delta t^2$ $\quad g \approx 9.80\ \text{m/s}^2$

$\vec{v}_{AB}$ constant : $\vec{r}_{CB} = \vec{r}_{CA} + \vec{r}_{AB}$ $\quad \vec{v}_{CB} = \vec{v}_{CA} + \vec{v}_{AB} \qquad \vec{a}_{CB} = \vec{a}_{CA}$