Phys 111
Fall 2019

General Physics: Class Exam I

13 September 2019

Name: Solution **Total:** /70

Instructions

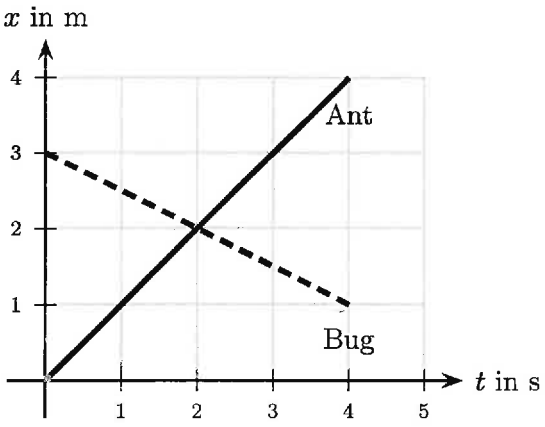
- There are 8 questions on 6 pages.
- Show your reasoning and calculations and always explain your answers.

Physical constants and useful formulae

$g = 9.80\,\mathrm{m/s^2}$

Question 1

An ant and a bug each walk along one direction and graphs of their positions vs. time are as illustrated. The solid graph represents the ant's motion and the dashed graph the bug's motion.



a) Are the ant and the bug ever at the same location at one instant? Explain your answer.

Yes at $t = 2s$ they are both at $x = 2m$

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b) Do the ant and the bug ever have the same speed? Explain your answer.

5 velocity = slope x vs t speed = magnitude of velocity

Ant slope = 1m/s ⇒ speed of ant = 1m/s always

Bug slope = -0.5m/s ⇒ speed of bug = 0.5m/s always

So speeds are never same

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since $a > 0$

$a = \frac{\Delta V}{\Delta t}$ $V_1 = -25\,m/s$ must increase to $-24\,m/s \to -23\,m/s \to \ldots$

$\Rightarrow$ speed decreases

Question 2

A ball moves along a horizontal surface. The position, velocity and acceleration of the ball are recorded (positive positions are to the right, negative to the left). The ball has a constant positive acceleration. At one instant it moves left with speed 25 m/s. Which of the following (choose one) is true at this instant?

i) The ball is moving with constant speed as time passes from this instant to the next.

ii) The ball is moving with increasing speed as time passes from this instant to the next.

iii) The ball is moving with decreasing speed as time passes from this instant to the next.

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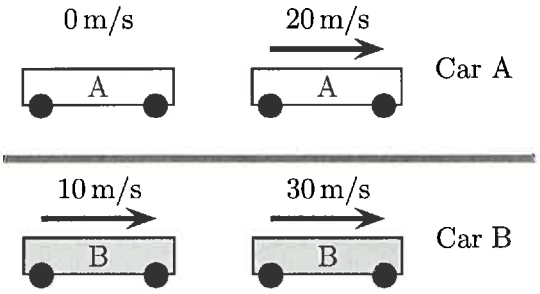
Question 3

Two cars each travel along a horizontal surface. The speed of each car is indicated at the same initial instant (left of diagram) and at the same final instant (right of diagram). The diagram is NOT to scale.



a) Which of the following (choose one) is true?

i) The acceleration of car A is smaller than the acceleration of car B.

ii) The acceleration of car A is larger than the acceleration of car B.

iii) The acceleration of car A is the same as the acceleration of car B.

$a = \frac{\Delta V}{\Delta t}$ $\Delta V = 20\,m/s$ Δt = same $\Rightarrow$ a same.

b) Which of the following (choose one) is true between the two instants?

i) Car A travels further than car B.

ii) Car B travels further than car A.

iii) Car A travels the same distance as car B.

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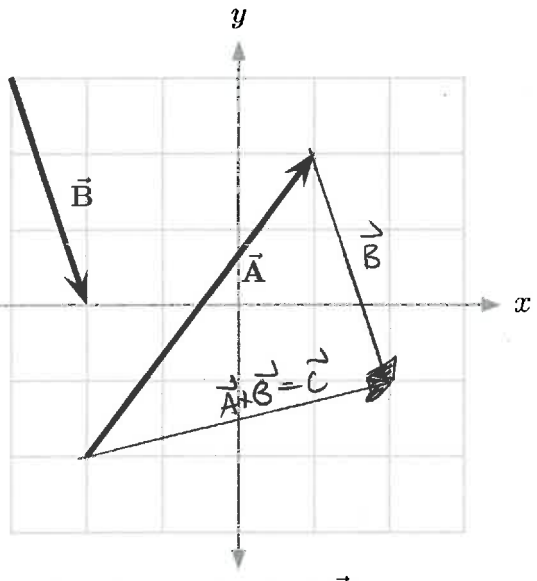
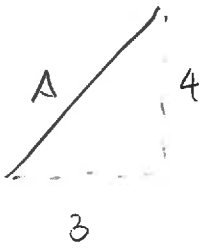
Car B is traveling faster so travels further.

Question 5

Two displacement vectors $\vec{A}$ and $\vec{B}$ are as illustrated. Each grid block is $1m$ long.



a) Determine the magnitude of $\vec{A}$.



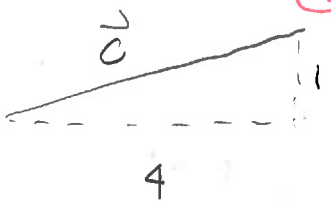
$A^2 = \sqrt{3^2+4^2}$ (+1) or formula

$= 25$

$A = 5$ (+2)

b) Determine $\vec{C} = \vec{A} + \vec{B}$. Sketch $\vec{C}$ on the grid. Determine the magnitude of $\vec{C}$.

(+3) (+2)



$C = \sqrt{1^2+4^2} = \sqrt{17} = 4.1m$ (+3)

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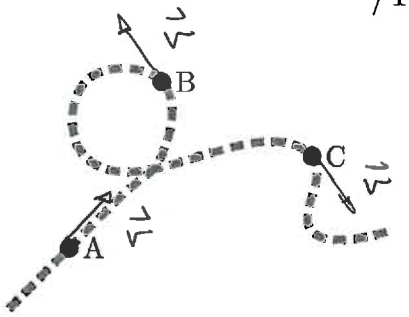
Question 6

A bug walks with a constant speed along a flat surface along the illustrated path, first passing A, then B and then C. During the period illustrated is the acceleration of the bug *zero at all times*? Explain your answer.



If accel = 0 then velocity is constant. The velocity vectors are not constant according to the diagram

Accel cannot always be zero

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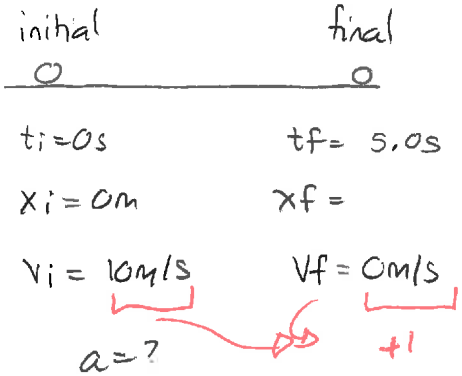
Question 4

A cart slides on a horizontal surface. At an initial instant it moves with speed 10 m/s. Immediately after this instant it slows (with constant acceleration) to a stop in 5.0 s.

a) Determine the acceleration of the cart while it slows to a stop.



$v_f = v_i + a\Delta t$] +1

$0m/s = 10m/s + a\ 5.0s$

$-10m/s = a\ 5.0s$] +1

$a = -2.0m/s^2$

+1 +1

b) Determine the distance traveled by the cart while it slows to a stop.

$x_f = x_i + v_i\Delta t + \frac{1}{2} a \Delta t^2$] +1

$= 0m + 10m/s \times 5.0s + \frac{1}{2}(-2.0\ m/s^2)(5.0s)^2$

$= 50m - 25m$

$= 25m$

+1 +2 +3

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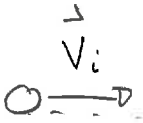
Question 7

A red ball and a blue ball are launched horizontally from a point 1.5 m above a horizontal floor. The red ball is launched with speed 8.0 m/s and the blue ball with twice the speed, 16.0 m/s. Ignoring air resistance, which of the following (choose one) is true?

i) Both balls hit the floor at the same time.
ii) The time taken for red ball to hit the floor is exactly half the time taken for the blue ball to hit the floor.
iii) The time taken for red ball to hit the floor is less than half the time taken for the blue ball to hit the floor.
iv) The red ball hits the floor before the blue ball but takes more than half the time taken for the blue ball to hit the floor.
v) The blue ball hits the floor before the red ball.

Explain your answer.



$y_f = y_i + v_{iy}\Delta t + \frac{1}{2}a_y \Delta t^2$

$0m = 1.5m + \cancel{0m/s\,\Delta t} + \frac{1}{2}(-9.8m/s^2)\Delta t^2$

$\Rightarrow \quad -1.5m = -4.9m/s^2 \Delta t^2$

$\Rightarrow \quad \Delta t = \sqrt{\frac{1.5m}{4.9m/s^2}} = 0.55s$

$t_i = 0s$
$x_i = 0m$
$y_i = 1.5m \qquad y_f = 0m$
$v_{ix} = v_i$
$v_{iy} = 0$
$a_x = 0 \qquad a_y = -9.8m/s^2$

Same regardless of v_i

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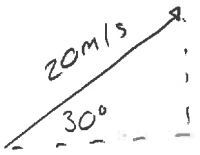
crucial: need $v_{iy} = 0$ or v_{iy} = same

+1

Question 8

A person launches a ball from the ground. The ball leaves the ground with speed 20 m/s at an angle of 30° above the horizontal.

a) Determine the horizontal and vertical components of the ball's velocity at launch.

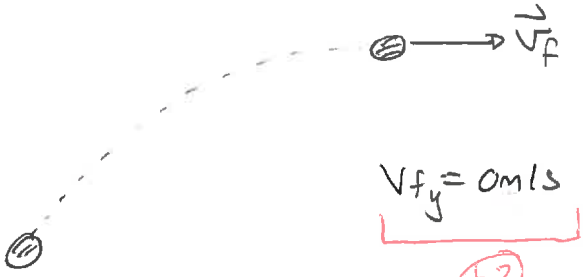


$V_{iy} = V_i \sin\theta = 20\,m/s \sin 30° = 10\,m/s$ (+1)

$V_{ix} = V_i \cos\theta = 20\,m/s \cos 30° = 17\,m/s$ (+1)

(+4)

b) Determine the time for the ball to reach its maximum height (ignore air resistance).



$V_{fy} = 0\,m/s$ (+2)

$t_i = 0\,s$ $t_f =$

$x_i = 0m$ $x_f =$

$y_i = 0m$ $y_f =$

$V_{ix} = 17\,m/s$ $V_{fx} =$

$V_{iy} = 10\,m/s$ $V_{fy} = 0\,m/s$

$a_x = 0\,m/s^2$ $a_y = -9.8\,m/s^2$ (+1)

(+2)

$V_{fy} = V_{iy} + a_y \Delta t \Rightarrow$ (+1)

$0\,m/s = 10\,m/s + (-9.8\,m/s^2)\Delta t$

$\Rightarrow -10\,m/s = -9.8\,m/s^2 \Delta t$

$\Rightarrow \Delta t = \frac{10\,m/s}{9.8\,m/s^2} = 1.0\,s$

(+3)

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