Name Solutions
Exam 1 15 questions

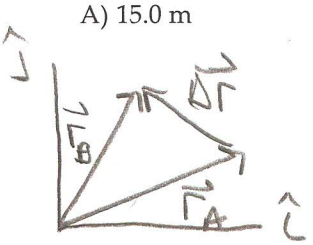
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) At the bottom of this page there is a capital letter in front of the page number. What is that letter?

A) A B) B C) C

2) Object A has a position as a function of time given by $\vec{r}_A(t) = 3.00\,t\,\hat{i} + 1.00\,t^2\,\hat{j}$. Object B has a position as a function of time given by $\vec{r}_B(t) = 4.00\,t\,\hat{i} - 1.00\,t^2\,\hat{j}$. All quantities are in SI units. What is the distance between object A and object B at time $t = 3.00$ s?

A) 15.0 m B) 2.27 m C) 34.6 m (D) 18.2 m E) 29.8 m



$\vec{r}_A + \Delta\vec{r} = \vec{r}_B$

$\therefore \Delta\vec{r} = \vec{r}_B - \vec{r}_A$

$\Delta\vec{r}(t) = [t]\hat{i} + [-2t^2]\hat{j}$

$\Delta\vec{r}\big|_{t=3} = 3\hat{i} - 18\hat{j}$

$\left|\Delta\vec{r}\big|_{t=3}\right| = \sqrt{3^2 + 18^2}$

$= 18.2$

3) A monkey is 20 m above the ground, sitting at the top of a tree. A person standing on the ground 10 meters from the base of the tree wants to feed the monkey. He uses an air cannon to shoot food to the monkey. If the person knows that the monkey is going to drop from the tree at the same instant that the air cannon fires, where should the air cannon be aimed so that the monkey can catch the food? Air resistance is small enough to be ignored and you can assume that the speed of sound is very large.

A) He should aim it below the monkey.

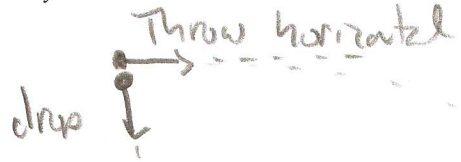
B) He should aim it above the monkey.

(C) He should aim it at the monkey. Class notes/Video

4) Two identical twins each have a rock and are standing on a level roof. One rock weighs twice as much as the other. The twin with heavier rock drops hers. At the same instant, the twin with the lighter rock throws her rock horizontally with a speed of 19.6 m/s. Ignoring the air, which rock hits the ground first?

A) the lighter one B) the heavy one

(C) they hit at the same time. D) there is no way to tell



$y(t) = y_0 + 0t - 4.9t^2$ is the $\hat{j}$ eqn. of motion for BOTH Rocks!!

∴ Must hit @ same time.

Constant — Changes because a_y

5) A baseball is thrown from center field to home plate. Ignoring the air, which of the following statements is true?

A) $v_x^2 + v_y^2 =$ constant.

B) The horizontal motion is independent of the vertical motion. "...not mix x and y."

C) The velocity of the ball is zero at the instant that it reaches its maximum height. — only $v_y = 0$

D) The trajectory will depend on the ball's mass as well as its initial velocity and launch angle.

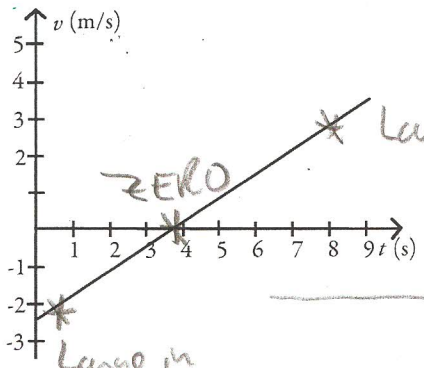
E) The acceleration is +g when the ball is rising and −g when falling.

NOT in any of our eqns.

direction of force does not change. ∴ direction of accel. does not change.

6) The velocity versus time graph for a moving object is shown in the figure. We can say that its speed_____.

$|\vec{v}|$ = Speed



A) increases and then decreases.

B) increases.

C) decreases and then increases.

D) decreases.

from $t = 0$ to $t \approx 3.8$ — from $t \approx 3.8$ to ...

7) Ignoring the air, when an object is dropped its _____.

A) acceleration increases.

B) velocity increases. NOTES

C) mass increases.

D) mass decreases.

NOT in our equations

Galileo.

8) A car accelerates from 10.0 m/s to 30.0 m/s at a rate of 3.00 m/s^2. How far does the car travel while accelerating?

A) 133 m B) 80.0 m C) 226 m D) 399 m

(1) $X(t)=x_0+v_0t+\frac{1}{2}at^2=10t+1.5t^2$ (1)

$V(t)=V_0+at=10+3t$ (2)

@ $t=t_1, V_1=30, x=x_1$

(2) $\rightarrow 30=10+3t_1$

$\therefore t_1=6.67$

(1) $\rightarrow x_1=10t_1+1.5t_1^2=133.4$

9) A boy throws a penny of off a building at an angle of 55 degrees. Ignoring the air, which of the following can be said about the penny at the instant when it has reached its maximum height?

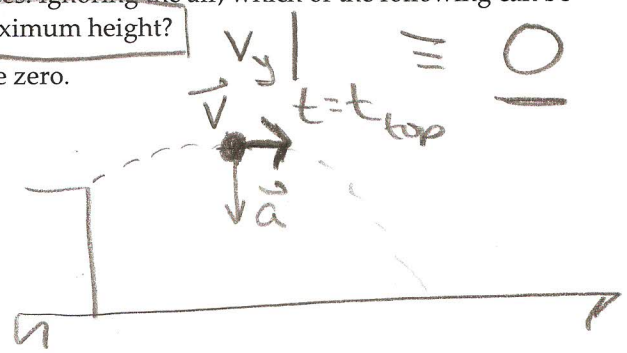
A) the horizontal and vertical components of its velocity are zero.

B) the horizontal component of its velocity is zero.

C) its acceleration is zero.

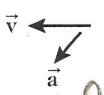
D) its velocity and acceleration are both zero.

E) its velocity is perpendicular to the acceleration.



10) Shown here are the velocity and acceleration vectors for several different objects. For which object is the velocity changing while its speed is not changing?

A)



Object turning left and speeding up

accelerating change velocities.

B)

Moving straight and speeding up

"Physics Speak" is saying $|\vec{V}|$ = constant, but direction of $\vec{V}$ is changing.

OVER

C)  Turning left but $|\vec{v}| \equiv$ constant since $\vec{a}$ is $\perp$ to $\vec{v}$

D)  Veering right and slowing down

E) None of these cases

11) The velocity, in m/s, of an object is given by the expression $v(t) = 3.00 + 4.00t^2$, where t is in seconds. Determine the position of the object as a function of time if it is located at $x = 1.00$ m at time $t = 0.000$ s.

A) $4.00\,t + 1.00$

B) $1.00 + 3.00\,t + 1.33t^3$

C) 1.33

D) $3.00\,t + 1.33t^3$

E) $4.00t$

$$V(t) = \frac{dx(t)}{dt}$$

$$\therefore \int dx(t) = \int v(t)\,dt$$

$$X(t) = \int (3 + 4t^2)\,dt$$

$$X(t) = 3t + \frac{4t^3}{3} + \text{constant}$$

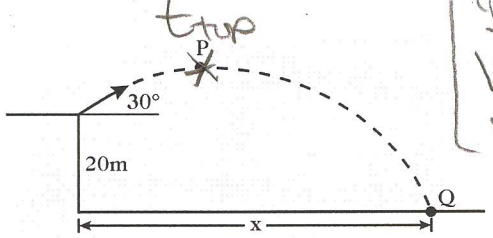
Given: $X(t=0) \equiv 1 = 3(0) + \frac{4(0)^3}{3} + \text{constant}$

$$\therefore \text{constant} = 1$$

@ $t = t_{top}$, $V_y = 0$

[3] $\rightarrow V_{x_{top}} = 940$

$\therefore \vec{V}_{top} = 940\hat{i} + 0\hat{j}$



$X(t) = \ldots$ [1]
$y(t) = \ldots$ [2]
$V_x(t) = 940$ [3]
$V_y(t) = 96 - 9.8t$ [4]

12) A projectile is fired from the origin (at y = 0 m) as shown in the figure. The initial velocity components are v_{ox} = 940 m/s and v_{oy} = 96 m/s. The projectile reaches maximum height at point P, then it falls and strikes the ground at point Q. The speed at point P is _____.

A) 0 m/s (B) 940 m/s C) 96 m/s D) 1036 m/s E) 945 m/s

$|\vec{V}_{top}| = \sqrt{940^2 + 0^2} = 940$

No real "work" here IF you rigorously understand the process

13) A airplane that is flying horizontally needs to accelerate at a constant rate from a speed of 200 m/s to a speed of 240 m/s while it flies a horizontal distance of 1.20 km. What must its acceleration be?

A) 4.44 m/s^2 B) 1.34 m/s^2 C) 2.45 m/s^2 (D) 7.33 m/s^2 E) 5.78 m/s^2

$t = 0$
$X_0 = 0$
$V_0 = 200$

$t = t_1$
$X_1 = 1200$
$V_1 = 240$

[1] $X(t) = X_0 + v_0 t + \frac{1}{2}at^2 = 200t + \frac{1}{2}at^2$ [1]
$V(t) = V_0 + at = 200 + at$ [2]

@ $t = t_1$, $X_1 = 1200$, $V_1 = 240$

[2] $\rightarrow 240 = 200 + at_1$

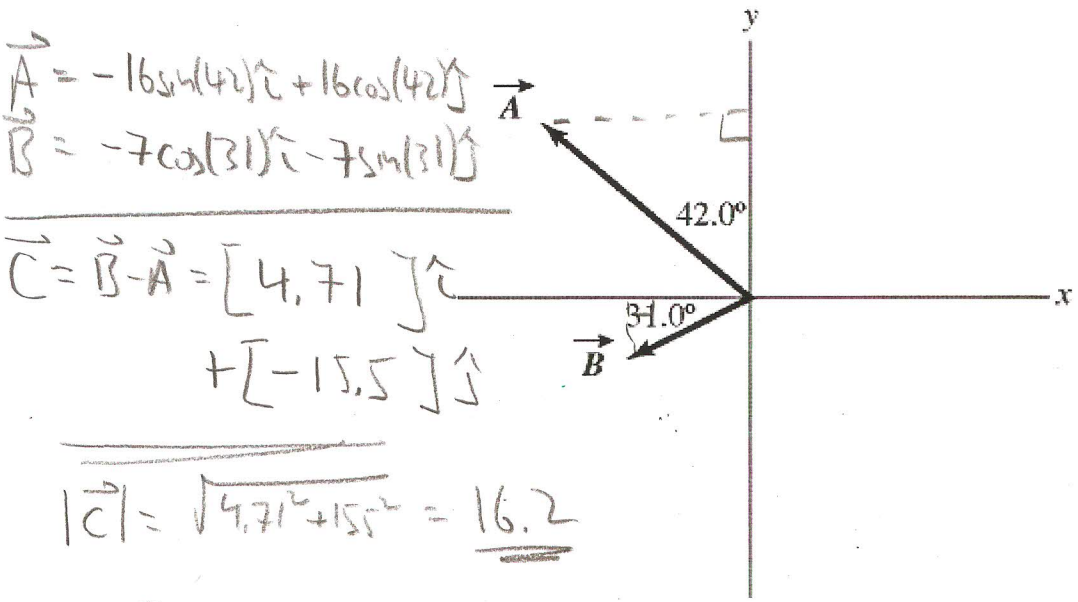
$\therefore t_1 = \frac{40}{a}$

[1] $\rightarrow 1200 = 200\left(\frac{40}{a}\right) + \frac{1}{2}a\left(\frac{40}{a}\right)^2$

$\therefore a = 7.33\ m/s^2$

OVER

14) Vectors $\vec{A}$ and $\vec{B}$ are shown in the figure. Vector $\vec{C}$ is given by $\vec{C} = \vec{B} - \vec{A}$. The magnitude of vector $\vec{A}$ is 16.0 units, and the magnitude of vector $\vec{B}$ is 7.00 units. What is the magnitude of vector $\vec{C}$?



$\vec{A} = -16\sin(42)\hat{i} + 16\cos(42)\hat{j}$

$\vec{B} = -7\cos(31)\hat{i} - 7\sin(31)\hat{j}$

$\vec{C} = \vec{B} - \vec{A} = [4.71]\hat{i} + [-15.5]\hat{j}$

$|\vec{C}| = \sqrt{4.71^2 + 15.5^2} = 16.2$

(A) 16.2 B) 17.5 C) 9.00 D) 9.53 E) 15.5

15) An object has a position given by $\vec{r} = [2.0 + 5.00\,t]\hat{i} + [3.0 - 2.00\,t^2]\,\hat{j}$, where quantities are in SI units. What is the speed of the object at time $t = 2.00$ s?

A) 13.0 m/s B) 6.40 m/s (C) 9.43 m/s D) 7.00 m/s E) 7.65 m/s

$\vec{v}(t) = \frac{d}{dt}\vec{r}(t) = 5\hat{i} - 4t\hat{j}$

$\vec{v}(t=2) = 5\hat{i} - 8\hat{j}$

$|\vec{v}(t=2)| = \sqrt{5^2 + 8^2} = 9.43$