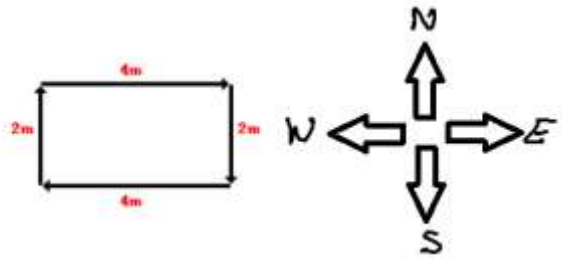
Physics I

Set no. 2

1. Consider the motion depicted in the diagram below. A man walks 4 meters East, 2 meters South, 4 meters West, and finally 2 meters North. Please find:
   a) the distance (path length, trajectory length) that man has walked,
   b) the displacement, $\Delta\vec{r}$, of that man.



2. A plane traveling north at 200m/s (the first stage of the flight) turns and then travels south at 200m/s (the second stage of the flight) . Let us assume that *x*-axis is directed on the east and the *y*-axis – on the north. Please:

   a) find the velocity vector $\vec{v}_1$ in the first stage
   b) find the velocity vector $\vec{v}_2$ in the second stage
   c) determine the change in velocity vector $\Delta\vec{v}$ and calculate its magnitude.

E 3. A car travels 30 km North and then runs East for 0.5 h at the velocity of 80 km/h. Please find average speed and average velocity during this route.

E 4. The x-coordinate (1D motion) of a particle in meters is given by $x(t) = 16t - 3t^3$, where the time t is in seconds. Please find the time t_r for which the particle is momentarily at rest at.

5. The x-coordinate of a particle in meters is given by $x(t) = 16t - 3t^3$, where the time t is in seconds. Please find:

E a) the displacement Δx between $t_1 = 2$ s and $t_2 = 4$ s,

E b) the average velocity for that time range (see above),

c) the path length (distance) for $t \in [2,4]s$

d) the average speed of this object for $t \in [2,4]s$

e) the distance for $t \in [0,3]s$

E 6. A drag racing car starts from rest at t = 0 and moves along a straight line with velocity given by $v = bt^2$, where b is a positive constant. Please find the expression for the distance travelled by this car from its position at t = 0.

7. A ball rolls up a slope. At the end of three seconds its velocity is 20 cm/s; at the end of eight seconds its velocity is 0. Please determine the magnitude of the average acceleration from the third to the eighth second. What is the direction of $\vec{a}_{AV}$ in relation to $\vec{v}$?

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8. The coordinate of an object is given as a function of time by $x(t) = 7t - 3t^2$, where x is in meters and t is in seconds. Please calculate:
   a) the average velocity over the interval from t = 0 to t = 4 s,
   b) the magnitude of the average velocity in that time range,
   c) the distance and the average speed from t = 0 to t = 4 s.

9. The movement of the rocket is described as follows:

$$\vec{r} = [2,5,6] + [2,2,1]t + [2,4,0]t^2$$

where time *t* and all coefficients are in SI units. Please:

a) find the formula for x(t) ; y(t) and z(t),
b) calculate $v_x(t)$; $v_y(t)$; v_z (t), where v_x , v_y , v_z are velocity vector components (coordinates),
c) determine $a_x(t)$; $a_y(t)$; a_z (t), where a_x , a_y , a_z are acceleration components (coordinates),
d) write $\vec{V}$ and $\vec{a}$ using their components and the unit vectors $\hat{\imath}$, $\hat{\jmath}$, $\hat{k}$.

10. The position of the body is given by (A, B, ω - positive constants):

a) $\vec{r} = [At,\ Bt^2]$

b) $x(t) = A\sin(\omega t)$
   $y(t) = Bt$

c) $\vec{r} = A\cos\omega t\ \hat{\imath} + A\sin\omega t\ \hat{\jmath}$

Please:

a) determine the value (magnitude) of the acceleration and the velocity vector at time t= 0,
b) find the trajectory (path equation) in form of y(x).

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11. The position vector of the body is given by $\vec{r} = A\cos\omega t\ \hat{\imath} + B\sin\omega t\ \hat{\jmath}$. Please discuss the trajectory of the body if (A,B ≥ 0, $\omega > 0$):

a) A = B = 0

b) A = B ≠ 0

c) A ≠ B and A ≠ 0 and B ≠ 0

12. The position vector of the body is given by $\vec{r} = A\cos\omega t\,\hat{\imath} + B\sin(\omega t + \phi)\,\hat{\jmath}$ where A, B, ω - positive constants. Please discuss the trajectory of the body if:

a) $\phi = 90°$ b) $\phi = 180°$ c) $\phi = -90°$ d) $\phi = 270°$ e) $\phi = -180°$

13. The position vector of the body is given by:

a) $\vec{r} = A\cos(2\omega t)\,\hat{\imath} + B\sin(\omega t)\,\hat{\jmath}$.

b) $\vec{r} = A\cos(2\omega t)\,\hat{\imath} + B\cos(\omega t)\,\hat{\jmath}$

Please determine the trajectory equation of the body.