# Physics Assignment#01

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**Q1.** distance = 40 km , speed = 30 km/h
displace = 40 km , speed = 60 km/h
moving in positive x direction

a) average velocity during full 80 km trip.

$V_{avg} = \frac{\text{total displacement}}{\text{total time}}$

$V_{avg} = \frac{80}{2}$

$V_{avg} = 40 \text{ km/h}$

$S = \frac{d}{t}$ $\quad S = \frac{d}{t}$

$30 = \frac{40}{t}$ $\quad 60 = \frac{40}{t}$

$t = \frac{40}{30}$ $\quad t = \frac{40}{60}$

total time = 2 hours

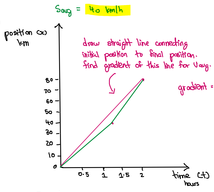
b) average speed

$S_{avg} = \frac{\text{total distance}}{\text{total time}}$

$S_{avg} = \frac{80}{2}$

$S_{avg} = 40 \text{ km/h}$

c)




**Q2.** $u = 30$ m/s
$v = 0$ m/s
$g = 9.8$ m/s²

$v = u + at$
$0 = 30 + (-9.8)(t)$
$9.8t = 30$
$t = 3.06$ s for reaching maximum height
total time = 3.06 x 2
total time = 6.12 s

**Q3.** distance = 50m
time = 5 s
v = 16 m/s

b) $v = u + at$
$16 = u + a(5)$
$u + 5a = 16$

$u = 16 - 5a$
$0 = 16 - 5(2.4)$
$u = 4$ m/s

a) $v^2 = u^2 + 2as$
$16^2 = u^2 + 2(a)(50)$
$u^2 + 100a = 256$
$(16 - 5a)^2 + 100a = 256$
$256 - 160a + 25a^2 + 100a = 256$
$25a^2 - 60a = 0$
$5a^2 - 12a = 0$
$a(5a - 12) = 0$
$a = 0$ $\quad a = \frac{12}{5}$
$a = 2.4$ m/s²

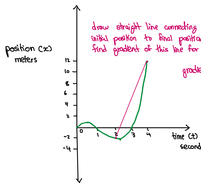
**Q4.** $x = 3t - 4t^2 + t^3$

a) $t=1 \longrightarrow x = 3(1) - 4(1)^2 + (1)^3 = 0$ meters
b) $t=2 \longrightarrow x = 3(2) - 4(2)^2 + (2)^3 = -2$ meters
c) $t=3 \longrightarrow x = 3(3) - 4(3)^2 + (3)^3 = 0$ meters
d) $t=4 \longrightarrow x = 3(4) - 4(4)^2 + (4)^3 = 12$ meters
e) displacement b/w t=0 and t=4 → 12 meters
f) Vavg b/w t=2 and t=4

$V_{avg} = \frac{\text{change in position}}{\text{change in time}}$

$= \frac{14}{2} = 7$ m/s

g)




**Q5.** $x = 21t + 5t^2$

a) $V_{avg} = \frac{\text{change in } x}{\text{change in } t}$

$V_{avg} = \frac{104}{3}$

$V_{avg} = 35$ m/s

$t=0$
$x = 21(0) + 5(0)$
$x = 0$m

$t=3$
$x = 21(3) + 5(3)^2$
$x = 108$m

b) $v(t) = \frac{dx}{dt}$

$\frac{dx}{dt} = 21 + 10t$
$v(t) = 21 + 10t$
$v(3) = 21 + 10(3)$
$v(3) = 51$ m/s

c) $a(t) = \frac{dv}{dt}$

$\frac{dv}{dt} = 10$
$a(3) = 10$ m/s²

**Q6.** radius = 5m
$\omega = 12$ rad/s
at t=0 , $\theta = 1.5$

a) $x(t) = r\cos(\omega t + \phi)$
$v(t) = -r\omega \sin(\omega t + \phi)$
$a(t) = -r\omega^2 \cos(\omega t + \phi)$
} SHM equations

finding $\phi \longrightarrow$ $x(t) = r\cos(\omega t + \phi)$
$x(0) = 5\cos(12(0) + \phi)$
$1.5 = 5\cos(\phi)$
$\phi = 1.266 + 2\pi$ $\quad$ ($\phi$ positive $\longrightarrow$ anticlockwise)

$x(t) = (5)\cos(12t + 1.266)$
$v(t) = -(5)(12)\sin(12t + 1.266)$
$a(t) = -(5)(12)^2\cos(12t + 1.266)$

$x(t) = 5\cos(12t + 1.266)$
$v(t) = -60\sin(12t + 1.266)$
$a(t) = -720\cos(12t + 1.266)$

**Q7.** initial x = -2m , t=0
final x = 6m , t=2
additionally x = 0 , t=1

$x_f - x_i = ut + \frac{1}{2}at^2$
$0 - (-2) = u(1) + \frac{1}{2}a(1)^2$
$2 = u + \frac{a}{2}$ — (1)

$6 - (-2) = u(2) + \frac{1}{2}a(2)^2$
$8 = 2u + 2a$
$4 = u + a$ — (2)

$2 - \frac{a}{2} = 4 - a$
$a - \frac{a}{2} = 2$
$a = 4$ m/s² → constant acceleration in positive x direction

**Q8.** $r_i = 5i + 6j + 2k$ m
$v_i = -2i + 8j - 2k$ m
t = 6s

$v = \frac{dr}{dt}$

$v = \frac{\Delta r}{\Delta t} = \frac{(-2i + 8j - 2k) - (5i + 6j + 2k)}{6s}$

$v = \frac{-7i + 2j - 4k}{6s}$

$v = (-0.7i + 1.3j - 0.4k)$ m/s

$a = \frac{dv}{dt}$

$a = \frac{\Delta v}{\Delta t} = \frac{-0.7i + 1.3j - 0.4k}{6s}$

$a = (-0.07i + 0.13j - 0.04k)$ m/s²

**Q9.** $r = (2t^3 - 5t)i - (6 - 7t^2)j$

a) $r = (2(2)^3 - 5(2))i - (6 - 7(2)^2)j$
$r = (6i + 16j)$

b) $v = \frac{dr}{dt}$

$\frac{dr}{dt} = (6t^2 - 5)i + 28t^2j$
$v = (6t^2 - 5)i + 28t^2j$
$v = (6(3)^2 - 5)i + 28(3)^2j$
$v = 49i + 252j$

c) $a = \frac{dv}{dt}$

$\frac{dv}{dt} = 12ti + 56tj$
$a = 12ti + 56tj$
$a = 12(3)i + 56(3)j$
$a = 36i + 168j$

d) $\theta = \tan^{-1}\left(\frac{252}{49}\right)$

$\theta = 80.15$

**Q10** $v = (7.6i + 6.1j)$ m/s at h = 9.1m

a) $v^2 = u^2 + 2as$
$0 = 6.1^2 + 2(-9.8)(s)$
$s = 1.8498$ m

Total h = 9.1 + 1.8498 = 11.0 m

b) $v = u + at$
$0 = 6.1 + (-9.8)(t)$
$t = 0.6224$

$v^2 = u^2 + 2as$
$(6.1)^2 = u^2 + 2(-9.8)(9.1)$
$u = 14.68$

$v = u + at$
$6.1 = 14.68 + (-9.8)(t)$
$t = 0.876$

total t = 1.1998 x 2 = 2.4996
d = ut
d = 7.6 x 2.496
d = 22.9 m

c) horizontal → 7.6
vertical → ?

$v^2 = u^2 + 2as$
$v^2 = 6^2 + 2(-9.8)(18)$
$v^2 = 194.68$
$v = (7.6i - 14.08j)$ m/s

$|v| = \sqrt{7.6^2 + (-14.08)^2}$
$|v| = 16.00$ m/s

d) $\theta = \tan^{-1}\left(\frac{-14.08}{7.6}\right)$

$\theta = -62.6°$ (-ve sign indicates below horizontal)