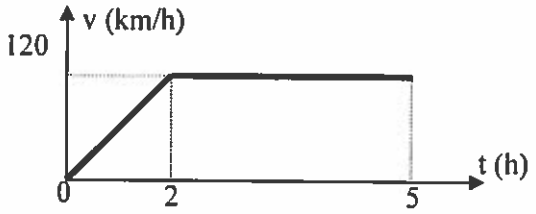
Chapter 2 (Motion along a strait line)

1- The figure represents the straight-line motion of a car.
What is the distance traveled by the car from t = 0 to t = 5 h? (A: 480 km)



2- A particle moves along the x-axis according to the equation: **x = 50*t + 10*t**2**
where x is in m and t is in s. Calculate the instantaneous velocity of the particle at t = 3s. (A: 110 m/s)

3- A balloon carrying a package is ascending (going vertically upward) at the rate of 12 m/s. When it is 80 m above the ground the package is released. How long does the package take to reach the ground? (A: 5.4 s)

4- The position of a particle moving along the x axis is described by the equation

$$x(t) = 5.0 + 2.0t + t^{**}3$$

Find its average acceleration for the time interval t = 1.0 s to t = 2.0 s. (A: 9.0 m/s**2)

5-A racing car traveling with constant acceleration increases its speed from 10 m/s to 30 m/s over a distance of 80 m? How long does this take? (A: 4.0 s)

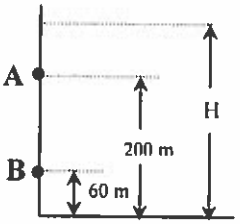
6- An object is thrown vertically upward at 35 m/s. Taking $g = 10\ m/s^2$, the velocity of the object after 5 seconds later is: (A: 15 m/s downward)

7- A stone is thrown vertically upward with an initial speed of 19.5 m/s. It will rise to a maximum height of: (A:19.4 m)

8- A stone is released from rest from the edge of a building 190 m above the ground. Neglecting air resistance, the speed of the stone, just before striking the ground, is: (A: 61 m/s)

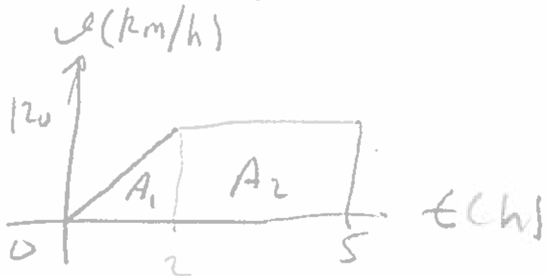
9- A projectile is shot vertically upward with a given initial velocity. It reaches a maximum height of 100 m. If, on a second shot, the initial velocity is doubled then the projectile will reach a maximum height of: (A: 400 m)

10- An object is released from rest at a height H. It takes 2.00 s for the object to fall from point A to point B (see the Figure). What is the initial height H? (A: 385 m)



(1)

- distance travelled by the car t (0 → 5h)



$$v = \frac{\Delta x}{\Delta t} \approx \frac{\partial x}{\partial t}$$

$$x = \int_i^f v\,dt = \text{Area under the graph}$$

$$A = A_1 + A_2$$

$$= \tfrac{1}{2}(2)(120) + (120)(3)$$

$$= 120 + 360 = 480\,(km)$$

---

(2) $x = 50t + 10t^2$

m: (m)
t: (s)
$v_{instantaneous_3} = ?$ $(t = 3s)$

$$v = \frac{\partial x}{\partial t}$$

$$= 50 + 20t$$

$$v_3 = 50 + 20(3)$$

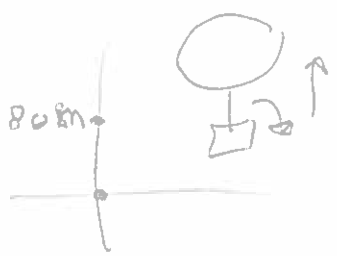
$$= 110\,(m/s)$$

---

(3) $v = +12\,(m/s)$

$x = 80\,m$

$t = ?$



(3)

(2)

a → b

$u_i = +12$ m/s

$u_f = 0$

$x = ?$

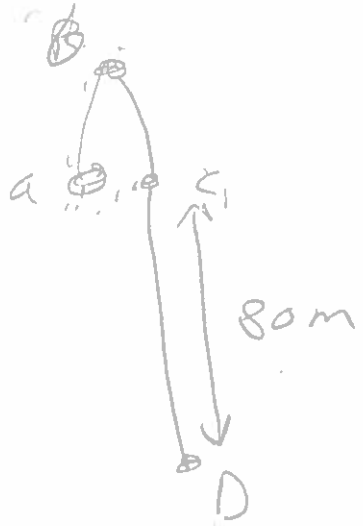
$t = ?$

$a = -9.8$

$u = u_0 + at$

$0 = 12 + (-9.8)t$

$t = \frac{-12}{-9.8} = \boxed{1.2\text{s}}$



$x_{up} = \frac{1}{2}at^2 + u_0 t$

$= \frac{1}{2}(-9.8)(1.2)^2 + (12)(1.2)$

$= -7.29 \quad +14.69$

$= +7.3$

B → C

(down)

$u_i = 0$

$u_f = ?$

$x = ?$

$t = 1.2$

$a = g$

$x = u_0 t + \frac{1}{2}at^2$

$= 0 + \frac{1}{2}(-9.8)(1.2)^2$

$= -7.3$

b → D

$u_i = 0$

$u_f = ?$

$x = 87.3$

$t = ?$

$a = -g$

$x = u_0 t + \frac{1}{2}at^2$

$-87.3 = 0 + \frac{1}{2}(-9.8)t^2$

$t = \mp 4.2$ s

$t_{total} = t_{a\to b} + t_{b\to D}$

$= 1.2 + 4.2$

$\boxed{t = 5.4\text{ s}}$

(3)

A → D

$v_i = +12\ m/s$

$v_f = ?$

$X = -80\ m$

$t = ?$

$a = -9.8$

$X = v_0 t + \frac{1}{2} a t^2$

$-80 = (12)t + \frac{1}{2}(-9.8)t^2$

$v^2 = v_0^2 + 2aX$

$= +144 + 2(-9.8)(-80)$

$v = \pm 41$

$v = v_0 + at$

$-41 = 12 + (-9.8)t$

$t = 5.4\ s$

(4) $X = 5 + 2t + t^3$

$\vec{a}_{av} = ?\quad t_1 = 1s \rightarrow t_2 = 2s$

$v = 2 + 3t^2$

$a(t) = 6t$

$a_{(2)} = 12\ m/s^2 \qquad a_{(1)} = 6\ m/s^2$

$\vec{a} = \frac{a_1 + a_2}{2} = \frac{12+6}{2} = 9\ m/s^2$

---

(5) $v_i = 10\ m/s$

$v_2 = 30\ m/s$

$X = 80\ m$

$t = ??$

$\bar{v} = \frac{\Delta X}{\Delta t}$

$\left(\frac{10+30}{2}\right) = \frac{80}{t}$

$\therefore t = \frac{80}{20} = 4s$

---

(6) $v_i = +35\ m/s$

$g = -9.8\ m/s^2$

$t = 5\ s$

$v_f = ??$

check ascending time

$v_i = 35 \qquad v = v_0 + at$

$v_R = 0 \qquad 0 = +35 + (-10)t$

$t = ? \qquad t = 3.5\ s$

$X = ?$

$a = -g$

B → C

$u_i = 0$

$u_f = ?$

$t = 1.5\,s$

$a = -g$

$X = ?$

$u = u_0 + at$

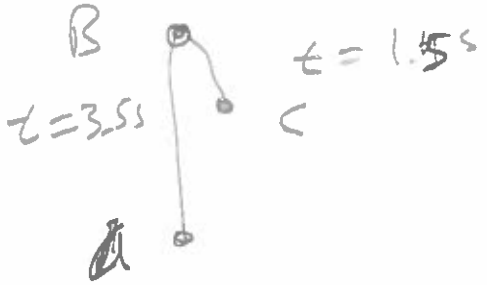
$= 0 + (-10)(1.5)$

$u = -15\ m/s$

or $u = u_0 + at$

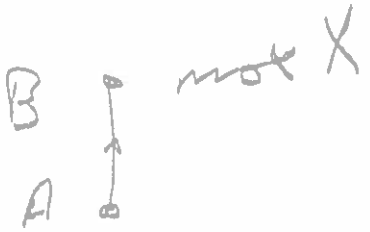
$= 35 + (-10)(5)$

$t = -15\,s$



(7) $u_i = +19.5\ m/s$

$X_{maximum} = ?!$



at B:

$u_i = +19.5$

$u_f = 0$

$t = ?$

$X = ?$

$a = g$

$u^2 = u_0^2 + 2aX$

$0 = (19.5)^2 + 2(-9.8)X$

$\frac{-380.25}{-19.6} = 19.4 = X_{max}$

(8) $u_i = 0$

$u_f = ?$

$X = -190\,m$

$t = ?$

$a = -9$

$v^2 = u_0^2 + 2aX$

$= 0 + 2(-9.8)(-190)$

$v = \pm 61\ m/s$

---

(9) $u_i =$

$u_f =$

$X = 100\,m$

$t = 1\,s$

$a = -9$

(1) $v^2 = u_0^2 + 2aX$

$0 = u_0^2 + 2aX$

$-u_0^2 = 2aX$

A: $X = 100\,m$, u_i

B: $X = ?$, $u_{i,B} = 2u_i$

$\therefore \dfrac{u_{0A}^2}{u_{0B}^2} = \dfrac{2aX_A}{2aX_B}$

$\dfrac{u_{0A}^2}{(2u_0)^2_A} = \dfrac{100}{X_B}$

$\therefore \dfrac{u_{0A}^2}{4u_{0A}^2} = \dfrac{100}{X_B}$

$\therefore X_B = 400\,m$

(16) IT = 15

$u_i = ?$

$u_f = ?$

$t = 25$

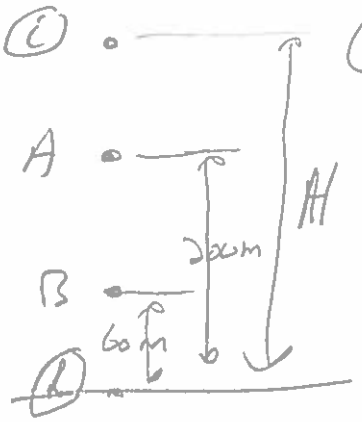
$x = -140$

$a = -9$

$$x = u_0 t + \frac{1}{2} a t^2$$

$$-140 = 25u_0 + \frac{1}{2}(-9.8)(4)$$

(7)



A → B

$X = -140$

$t = 2s$

$u_0 = ?$

$u_{RA} = ?$

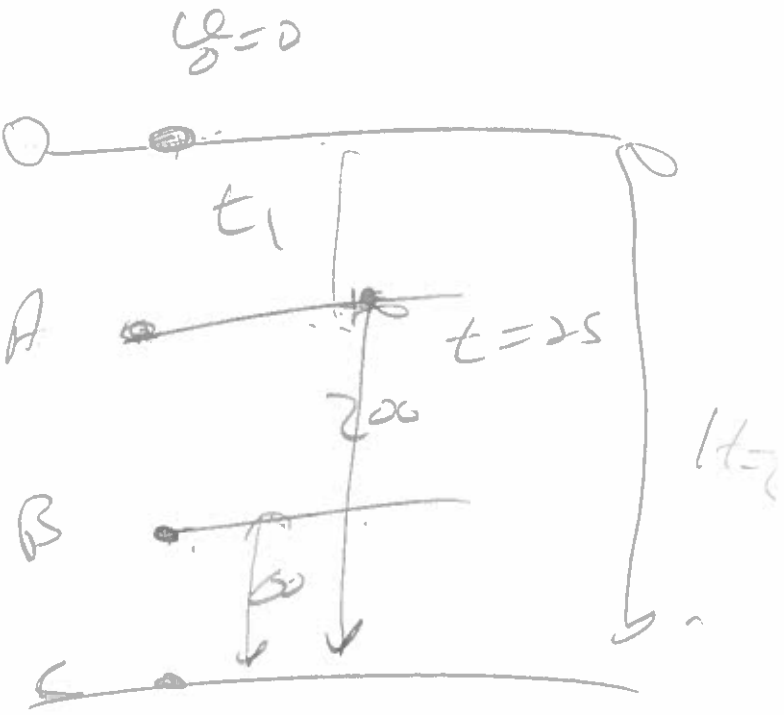
$a = -9.8$

~~$t = t_2 - t_1$~~

$X = u_0 t + \frac{1}{2} a t^2$

$-140 = 2u_0 + \frac{1}{2}(-9.8)(4)$

$\frac{(-140 + 19.6)}{2} = u_0 = -60.2$



O → A

$u_0 = 0$

$u_A = u_{RA}$

$t = t_1$

O → A

$u_i = 0$

$u_A = -60.2$

$t = ?$

$x = ?$

$a = -9.8$

$X = u_0 t + \frac{1}{2} a t^2$ α

$u = u_0 + 2at$ α

$u^2 = u_0^2 + 2aX$

$(-60.2)^2 = 0 + 2(-9.8)X$

$184 + 200 = 385$