Chapter 2 Homework Solutions – phys101-081

1. **q1**

A car travels up a hill at a constant speed of 58.3 km/h and returns down the hill at a constant speed of 27.4 km/h. Calculate the average speed for the round trip in km/h and give to three significant digits.

$$\text{Averge speed} = \frac{s(\text{total distance})}{t(\text{total time})} = \frac{s1(\text{uphill}) + s2(\text{downhill})}{t1 + t2}$$

$$= \frac{(s1+s2)km}{\frac{(s1)km}{(58.3)km/h} + \frac{(s2)km}{(27.4)km/h}}$$

But $s1 = s2 = s$

$$= \frac{(2\not{s})km}{\frac{(\not{s})km}{(58.3)km/h} + \frac{(\not{s})km}{(27.4)km/h}}$$

$$= \frac{2}{\frac{1}{(58.3)km/h} + \frac{1}{(27.4)km/h}}$$

$$= \boxed{37.3}$$

Give the answer to exactly 3 significat figures and no need to give units; an answer such as 37.30 or 37.3km or +37.3 would result in zero score. if you want to write the units give it after a space: 37.3 km

2. **q2**

At a certain time a particle has a speed of 44.6 m/s in the poitive x direction, and 1.2 s later its speed was 24.3 m/s in the opposite direction. What is the average acceleration of the particle during this 1.2 s interval? Give the answer in m/s^2 and give three significant digits only.

$$\text{average acceleration} = \frac{\Delta v}{\Delta t} = \frac{-24.3-(44.6)}{1.2} = \boxed{-57.4}$$

3. **q3a**

An electron has a constant acceleration of +2.3 m/s^2. At a certain instant its velocity is +9.6 m/s. What is its velocity 2.52 s earlier? Give the answer in m/s and give two significant figures only.

Using $v = v_o + at$

with v=9.6 m/s at time 2.52 s and v_o is the unknown initial velocity

at t = 0.

$9.6 = vo + 2.3 \times 2.52$

$\Rightarrow vo = \boxed{3.8}$

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4. q3b

An electron has a constant acceleration of +2.3 m/s^2. At a certain instant its velocity is +9.6 m/s. What is its velocity 2.36 s later? Give the answer in m/s and give two significant figures only.

Using $v = v_o + at$

with vo = 9.6 m/s at t=0 and unknown final velocity v

at t = 2.36 s.

$v = 9.36 + 2.3 \times 2.36$

$\Rightarrow v = \boxed{15}$

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5. q4a

If the maximum acceleration that is tolerable for passengers in a subway train is 1.34 m/s^2 and subway stations are located 253 m apart. What is the maximum speed a subway train can attain between stations? Give the answer in m/s and give three significant figures.

The key point here is to understand that to attain maximum speed the train has to accelerate at 1.34 m/s^2 halfway to the next station and then decelerate at 1.34 m/s^2 for the second half.

Applying $v^2 = v_o^2 + 2a\Delta x$ for the first half (Δx=253/2, a = 1.34 and v_o=0)

v = $\boxed{18.4}$

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6. q4b

If the maximum acceleration that is tolerable for passengers in a subway train is 1.34 m/s^2 and subway stations are located 806 m apart. If a subway train stops for 20 s at each station, what is the maximum average speed of the train, from one start-up to the next? Give the answer in m/s and give three significant figures.

The journey consists of three parts: Station A to halfway, from halfway to Station B, and the stopping at station B for 20s. To solve this question, one has to again calculate the maximum speed as above (with the new values now).

Applying $v^2 = v_o^2 + 2a\Delta x$ for the first half (Δx=806/2, a = 1.34 and v_o=0)

vmax = 32.864 m/s

time (t1) to reach halfway:

Applying v=vo+at; (v=32.864, a =1.34, and vo=0)

t1 = (32.864-0)/1.34 = 24.5253 s = this is also equal to t2; and t3 = 20 s.

$$\text{average speed} = \frac{s_1 + s_2 + s_3}{t_1 + t_2 + t_3}$$

$$= \frac{s_1 + s_1 + s_3}{t_1 + t_1 + 20} \text{ from symmetry of the two journeys}$$

$$= \frac{2s_1}{2t_1 + 20}$$

$$= \frac{806}{2*24.5253 + 20}$$

$$= \boxed{11.7}$$

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7. q5

A rock is thrown vertically upward from ground level at time t = 0. At t= 1.6 s it passes the top of a tall tower, and 2.6 s later it reaches its maximum height. What is the height of the tower? Give the answer in *m* and give only 3 significant digits.

First consider the rock going from ground level to the maximum height to get the initial velocity of the rock:
Solving: $0 = v_o - 9.8*3.6$, gives vo = 35.28 m/s

Now consider the motion from the ground to the top of the tower only:
Using $\Delta y = v_o t + (1/2) a t^2 = 35.28*1.6 - 0.5*9.8*1.6^2 = \boxed{43.9}$

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8. q6

A jumbo jet must reach a speed of 396 km/h on the runway for takeoff. What is the lowest constant acceleration needed for takeoff a 2.7 km runway? Give the answer in m/s^2 and give three significant figures.

Δx=2700 m, vo= 0, v = 396/3.6 m/s, a = ?, t = ?

Solving $v^2 = v_o^2 + 2\,a\,\Delta x$ gives $a = \boxed{2.24}$