Dean Gadberry

NCTC PHYS 2425

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QUESTIONS

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1. Does a car speedometer measure speed, velocity, or both? Explain.

A car speedometer measures speed. It cannot measure velocity, as velocity is a vector and thus the speedometer would need to denote direction to also measure velocity.

5. Compare the acceleration of a motorcycle that accelerates from 80 km/h to 90km/h with the acceleration of a bicycle that accelerates from rest to 10km/h in the same time.

The acceleration of the both examples is the same because they both increased 10km/h in the same amount of time.

12. As a freely falling object speeds up, what is happening to its acceleration-does it increase, decrease, or stay the same?

(a) Ignore air resistance

As a freely falling object speeds up, in a vacuum, it's acceleration remains the same (-9.8m/s).

(b) Consider air resistence

As a freely falling object speeds up, encountering air resistance, its acceleration remains the same until it reaches terminal velocity, at which point it decreases.

14. Can an object have zero velocity and nonzero acceleration at the same time? Give examples.

Yes, an object can have zero velocity and nonzero acceleration at the same time. When I put my foot on the gas pedal, velocity starts at 0.

15. Can an object have zero acceleration and nonzero velocity at the same time? Give examples.

Yes, an object can have zero acceleraion and nonzero velocity at the same time. When I am running to class at maximum speed, my velocity is constant, but my acceleration is 0.

MISCONCEPTION QUESTIONS

1. In which of the following cases does a car have a negative velocity and a positive acceleration? A car that is traveling in the

(b) -x direction increasing in speed

7. At time $t = 0$ an object is traveling to the right along the +x axis at a speed of $10.0m/s$ with constant acceleration of $-2.0m/s^2$. Which statement is true?

(a) The object will slow down, eventually coming to a complete stop.

PROBLEMS

5. (II) You are driving home from school steadily at $95km/h$ for $210km$. It then begins to rain and you slow to $65km/h$. You arrive home after driving $4.5h$.

(a) How far is your hometown from school?

$$\frac{95km}{h} = \frac{210km}{t} \implies t = \frac{42}{19}h \approx 2.21h$$

$$4.5h = \frac{85.5}{19}h \implies \frac{85.5h}{19} - \frac{42h}{19} = \frac{43.5h}{19} \approx 2.29h$$

$$\frac{65km}{h} \times \frac{43.5h}{19} \approx 148.8km$$

$$\Delta x \approx 210km + 148.8km \approx 358km$$

(b) What was your average speed?

$$\overline{v} = \frac{\Delta x}{\Delta t} = \frac{358km}{4.5h} = 79.7km/h$$

16. (II) The position of an object along a straight tunnel as a function of time is plotted in Fig. 2-40. What is its instantaneous velocity (a) at $t = 10.0s$ and (b) at $t = 30.0s$? What is its averave velocity (c) between $t = 0$ and $t = 5.0s$, (d) between $t = 25.0s$ and $t = 30.0s$, and (e) between $t = 40.0s$ and $t = 50.0s$

(a)

$$v = \frac{x}{t} = \frac{2.5}{10} = 0.25m/s$$

(b)

$$v = \frac{x}{t} = \frac{16}{30} = 1.3m/s$$

(c)

$$\overline{v} = \frac{\Delta x}{\Delta t} = \frac{12}{5} = 0.4m/s$$

(d)

$$\overline{v} = \frac{\Delta x}{\Delta t} = \frac{16-8}{30-25} = 1.56m/s$$

(e)

$$\overline{v} = \frac{\Delta x}{\Delta t} = \frac{10 - 19}{50 - 40} = -1m/s$$

26. (II) A particle moves along the x axis. Its position as a function of time is given by $x = 4.8t + 7.3t^2$, where t is in seconds and x is in meters. What is the acceleration as a function of time?

$$a = \frac{dv}{dt} = \frac{d}{dt}[4.8t + 7.3t^2] = 14.6m/s^2$$

35. (I) A car accelerates from 13 m/s to 22 m/s in 6.5s. What was its acceleration? How far did it travel in this time? Assume constant acceleration.

$$\overline{a} = \frac{\Delta v}{\Delta t} = \frac{22 - 13}{6.5} \approx 1.38m/s^2$$

$$v_f^2 = v_0^2 + 2a\Delta x \implies 22 = 2(6.5)(1.38)\Delta x \implies \Delta x = \frac{22}{18} \approx 1.22m$$

36. (II) A world-class sprinter can reach a top speed (of about $11.5m/s$) in the first $18.0m$ of a race. What is the average acceleration of this sprinter and how long does it take her to reach that speed?

$$v_f^2 = v_0^2 + 2a\Delta x \implies 11.5^2 = 0 + 2a(18) \implies 11.5 = 6\sqrt{a} \implies a = \left(\frac{11.5}{6}\right)^2 \approx 3.67m/s^2$$

$$v_f = v_0 + at \implies 18 = 0 + 3.67t \implies t = \frac{18}{3.67} \approx 4.90s$$

38. (II) In coming to a stop, an old truck leaves skid marks $45m$ long on the highway. Assuming a deceleration of $6.00m/s^2$, estimate the speed of the truck just before braking.

$$v_f^2 = v_0^2 + 2a\Delta x$$

$$0 = v_0^2 + 2(-6.00m/s^2)(45m) \implies v_0^2 = 540 \implies v_0 = \sqrt{540} \approx 23.2m/s$$

52. (I) A stone is dropped from the top of a cliff. It is seen to hit the ground below after 3.25s. How high is the cliff?

$$\Delta x = v_0 t + \frac{1}{2}at^2 \implies \Delta x = (0)(3.25s) + \frac{1}{2}(-9.80m/s^2)(3.25s)^2 \implies \Delta x \approx 51.8m$$

56. (II) A baseball is hit almost straight up into the air with a speed of $22m/s$. Estimate (a) how high it goes, and (b) how long it is in the air. (c) What factors make this an estimate?

(a)

$$v_f^2 = v_0^2 + 2a\Delta x \implies 0 = 22m/s + 2(-9.80m/s^2)\Delta x \implies \Delta x = \frac{-22}{-19.6} \approx 1.12m$$

(b)

$$\Delta x = v_0 t + \frac{1}{2}at^2 \implies 1.12m = (22m/s)t + \frac{1}{2}(-9.80m/s^2)t^2 \implies 0 = -4.9t^2 + 22t - 1.12$$

$$t \approx 4.44s$$

(c)
Some factors which make this an estimate are air resistance and the fact that altitude determines acceleration due to gravity.

58. (II) The best rebounders in basketball have a vertical leap (that is, the vertical movement of a fixed point on their body) of about 120cm.

(a) What is their initial ”launch” speed off the ground?

$$v_f^2 = v_0^2 + 2a\Delta x \implies 0 = v_0^2 + 2(-9.80m/s^2)1.20m \implies v_0^2 = \sqrt{23.52} \approx 4.85m/s$$

(b) How long are they in the air?

$$\Delta x = v_0 t + \frac{1}{2}at^2 \implies 1.20m = (48.5m/s)t + \frac{1}{2}(-9.80m/s^2)t^2 \implies 0 = -4.9t^2 + 4.85t - 1.20$$

$$t \approx 1s$$

63. (II) A stone is thrown vertically upward with a speed of 15.5m/s from the edge of a cliff 75.0m high.

(a) How much later does it reach the bottom of the cliff?

$$\Delta x = v_0 t + \frac{1}{2}at^2 \implies -75m/s = (15.5m/s)t + \frac{1}{2}(-9.8m/s^2)t^2$$

$$t = 5.80s$$

(b) What is its speed just before hitting?

$$v_f^2 = v_0^2 + 2a\Delta x \implies v_{f2}^2 = (-15.5) + 2(-9.8)(75) \implies v_{f2} = \sqrt{1485.5} \approx 38.5m/s$$

(c) What total distance did it travel?

$$v_{f1}^2 = v_{01}^2 + 2a\Delta x_1 \implies 15.5m/s = 0 + 2(-9.8m/s^2)\Delta x_1 \implies \Delta x_1 = \frac{-240.25}{-19.6} \approx 12.26m$$

$$2x_1 + 75.0 = 99.5m$$

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