Physics 11 — 33 — Constant Acceleration Problems — KEY

1. Justin drives his mom's Hyundai 30 km in 45 minutes on the Malahat. What is his average velocity in a) km/h? b) m/s?

a) 40 km/h (1)

b) 11 m/s (1)

2. Luis gets his pilot's license and wishes to fly 2000 km in 4.0 hours (he is making a quick run to Mexico to deliver some "goods" for some guy he just met in a biker bar in Abbotsford). What average velocity in metres per second in required to accomplish this?

$\frac{2000}{4} \times \frac{1}{3600}$ 139 m/s 2

3. Justine gets in her father's Jaguar XK-S and travels in a straight line at 40 km/h for one hour and then at 60 km/h for two hours.

a) How far did she travel? $40 + 120$ 160 km (1)

b) Find the average velocity. $\frac{160}{3}$ 53 km/h (2)

4. Luis' plane accelerates on the runway, from rest, at 4.0 m/s^2. After 5.0 seconds, find the velocity and the distance travelled.

$v = v_0 + at = 4(5) =$ 20 m/s (2)

$d = \frac{1}{2}at^2 = \frac{1}{2}(4)(5)^2 =$ 50 m (2)

5. Brandon's 1985 Toyota Tercel attempts to pass a 1972 VW Westfalia. The Toyota's velocity increases from 50 to 100 km/h over 4.0 s. What was the average acceleration?

27.8 13.9

$a = \frac{\Delta v}{\Delta t} = \frac{v - v_0}{t} = \frac{13.9}{4} = 3.5$ 3.5 m/s^2 (2)

6. Jun is driving his Lancia convertible at 20 m/s when he applies the brakes—unusually for this car, they actually work and cause an acceleration of -2.0 m/s^2. How long will it take for the Lancia to stop?

~~$d = v_0 t + \frac{1}{2}at^2$~~

$v = v_0 + at$

$t = \frac{v - v_0}{a} = \frac{0 - 20}{-2} = 10$ s. 10 s (2)

7. Chilly builds a linear particle accelerator in his backyard. It will accelerate protons up to a velocity of 2.5 x 10^8 m/s over a displacement of 0.80 km.

a) Find the acceleration of the protons.

~~$a = \frac{v - v_0}{t}$~~ $v^2 = v_0^2 + 2ad$ $a = \frac{v^2 - v_0^2}{2d} = \frac{(2.5 \times 10^8)^2}{2(800)} =$ 3.9×10^{13} m/s^2

b) How long does it take the protons to travel the length of the accelerator?

$d = \left(\frac{v + v_0}{2}\right)t$ $t = \frac{2d}{v + v_0} = \frac{2(800)}{2.5 \times 10^8} =$ 6.4×10^{-6} s (2)

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8. Jesse drives his mom's Corolla into a concrete wall at 15 m/s.

a) He is wearing a seatbelt, so he decelerates over a distance of 0.80 m. What average acceleration did he experience?

~~$a = \frac{15}{t}$~~ $v^2 = v_0^2 + 2ad$

$a = \frac{v^2}{2d} = \frac{15^2}{2(.8)}$ $141\ m/s^2$ 2

b) Cole, in the passenger seat, is not wearing a seatbelt, and therefore decelerates over a distance of 5.0 cm—what average acceleration does he experience?

$a = \frac{v^2}{2d} = \frac{15^2}{2(.05)}$ $2.25 \times 10^3\ m/s^2$ 1

9. Kelvin falls out a window and hits the ground with a speed of 30 m/s. How high was the window? (the acceleration of gravity is 9.8 m/s^2)

$d = \frac{v^2}{2a} = \frac{30^2}{2(9.8)}$ 46 m 2

10. Carolina is running away from a very scary man, on a train. Carolina is running toward the back of the train at 5.2 m/s. The train is moving forward at 6.5 m/s. What is the velocity of Carolina with respect to the train tracks?

1.3 m/s forward. 1

11. Don rows a leaky boat 12 km down a crocodile-infested river in 2.0 h. Having forgotten his iPod on the shore at the start of the trip, he rows back upstream in 3.0 h.

$(v + v_r)2 = (v - v_r)3$ $v + v_r = 6$

$2v + 2v_r = 3v - 3v_r$ $v - v_r = 4$

$5v_r = v$

$v_r = 6 - v$

$v_r = v + 4$

$6 - v = v + 4$

$2 = 2v$ $v = 1$

a) How fast can Don row in still water? 5 km/h 2

b) How fast is the river current? 1 km/h 1

12. Ryan skids down an icy ski slope on his face, ~~with constant~~ acceleration. He slides 12m in the first 4.0 s. When will he have a velocity of 4.0 m/s?

~~$d = vt$~~ $d = \frac{1}{2}at^2$ $a = \frac{2d}{t^2} = \frac{2(12)}{4^2} = 1.5\ m/s^2$

$t = \frac{v - v_0}{a} = \frac{4 - 0}{1.5} =$ 2.7 s 2

13. Elia walks past Carla at 2.5 m/s. Carla—realizing that Elia still has her copy of the *Official Justin Bieber Guide to Being Really, Really, Cool*—hops on her tricycle and gives chase. Carla accelerates at 0.25 m/s^2.

a) How much time does it take Carla to catch Elia?

$d = 2.5t = \frac{1}{2}(.25)t^2$

$2.5 = \frac{1}{2}(.25)t$

~~50~~ 20 s = t 2

b) How far does Elia get before Carla catches up?

$d = 2.5(20)$ ~~200~~ 50 m 1

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