Example Questions for Quiz 2 - Solutions

Here are some questions that are similar to what will be on Quiz 2.
The quiz will have two 5 point questions and others to make up 20 points.

1. (2 points) How are speed and velocity different?

Speed is distance moved in any direction divided by time required.
Velocity is speed combined with direction of motion.
(They both have units of m/s, but with velocity a direction must also be specified.)

2. (2 points) If your car odometer indicates you have driven 150 km during the past 2 hours, what has been your average speed?

$$\bar{s} = \frac{d}{t} = \frac{150\,\text{km}}{2\,\text{h}} = 75\,\text{km/h}$$

3. (2 points) A satellite is moving at a speed of 25000 km/h. What is its speed in m/s?

$$25000\,\frac{\text{km}}{\text{h}} \cdot \left(\frac{1000}{1}\,\frac{\text{m}}{\text{km}}\right) \cdot \left(\frac{1}{3600}\,\frac{\text{h}}{\text{s}}\right) = 6944\,\frac{\text{m}}{\text{s}}$$

4. (4 points) A rocket accelerates in a straight line from 0 km/h to 1800 km/h in 25 s, what is its average acceleration in m/s^2?

$$\bar{a} = \frac{v_f - v_i}{t} = \frac{\left(1800\,\frac{\text{km}}{\text{h}} - 0\,\frac{\text{km}}{\text{h}}\right)}{25\,\text{s}} = \frac{\left(1800\,\frac{\text{km}}{\text{h}}\right) \cdot \left(\frac{1}{3600}\,\frac{\text{h}}{\text{s}}\right) \cdot \left(\frac{1000}{1}\,\frac{\text{m}}{\text{km}}\right)}{25\,s} = 20.0\,\frac{\text{m/s}}{\text{s}} = 20.0\,\frac{\text{m}}{\text{s}^2}$$

5. (2 points) A drag racer accelerates from standing still at a uniform rate of 8 m/s^2 for 10 s, how fast is it moving at the end?

$$v_f = v_i + a\,t = 0\,\text{m/s} + \left(8\,\text{m/s}^2\right) \cdot \left(10\,\text{s}\right) = 80\,\text{m/s}$$

6. (2 points) A drag racer accelerates from standing still at a uniform rate of 8 m/s^2 for 10 s, how far has it traveled?

$$d = \frac{1}{2}\,a\,t^2 = \frac{1}{2} \cdot \left(8\,\text{m/s}^2\right) \cdot \left(10\,\text{s}\right)^2 = 400\,\text{m}$$

7. (2 points) Why is a satellite moving around the earth at a constant speed of 8 km/s said to be accelerating?

Because its direction is constantly changing.

8. (2 points) A driver puts on the brakes and stops the car. The speed has changed and the car is said to have under gone an acceleration. What is special about the value of its acceleration?

The acceleration is negative because the speed is being decreased.

9. (5 points) Use Newton's Law of Gravitation to calculate the force between the Moon ($m_{\text{Moon}} = 7.35 \times 10^{22}\,\text{kg}$) and the Earth ($m_{\text{Earth}} = 5.97 \times 10^{24}\,\text{kg}$) using their separation distance of $d = 3.84 \times 10^{8}\,\text{m}$. Use your equation sheet to find Newton's Law of Gravitation with the value for its universal constant *G*.

$$F = G\,\frac{m_{\text{Moon}}\,m_{\text{Earth}}}{d^2_{\text{Moon-Earth}}} = \left(6.67 \times 10^{-11}\,\frac{\text{N} \cdot \text{m}^2}{\text{kg}^2}\right) \cdot \frac{\left(7.35 \times 10^{22}\,\text{kg}\right) \cdot \left(5.97 \times 10^{24}\,\text{kg}\right)}{\left(3.84 \times 10^{8}\,\text{m}\right)^2} = 1.98 \times 10^{20}\,\text{N}$$

10. (4 points) A rock is dropped off a bridge and hits the water 5 s later. How high is the bridge above the water?

$$d = \frac{1}{2}\,g\,t^2 = \frac{1}{2} \cdot \left(9.80\,\text{m/s}^2\right) \cdot \left(5\,\text{s}\right)^2 = 122.5\,\text{m}$$

11. (5 points) Calculate the local acceleration of gravity on the Mars ($m_{\text{Mars}} = 6.42\times10^{23}\,\text{kg}$). At the surface of the Mars, objects are a distance $d = r_{\text{Mars}} = 3.39\times10^{6}\,\text{m}$ from the center of the Mars. Your result will give you the value g_{Mars} which is significantly less than g_{Earth} = 9.80 m/s^2.

$$g_{\text{Mars}} = G\frac{m_{\text{Mars}}}{d^2} = \left(6.67\times10^{-11}\,\frac{\text{N}\cdot\text{m}^2}{\text{kg}^2}\right)\cdot\frac{6.42\times10^{23}\,\text{kg}}{(3.39\times10^{6}\,\text{m})^2} = 3.726\,\frac{\text{N}}{\text{kg}} = 3.726\,\frac{\text{m}}{\text{s}^2}$$

12. (2 points) An object moves around a circle of 2 m radius. What is the distance it must move to complete one trip around the circle?

It must travel the circumference of the circle: $d = 2\pi r = 2\pi(2\,\text{m}) = 4\pi\,\text{m} = 12.57\,\text{m}$

13. (2 points) An object moves around a circle of 2 m radius in 3 s. What is its speed?

$$d = st \quad \text{so} \quad s = \frac{d}{t} = \frac{2\pi r}{t} = \frac{4\pi\,\text{m}}{3\,\text{s}} = 4.19\,\text{m/s}$$

14. (2 points) An object moves around a circle of 2 m radius with a velocity of 5 m/s. What is the magnitude of its centripetal acceleration?

$$a_c = \frac{v^2}{r} = \frac{(5\,\text{m/s})^2}{2\,\text{m}} = 12.5\,\text{m/s}^2$$

15. (2 points) A object with a mass of 2 kg moving in a circle experiences a centripetal acceleration of 10 m/s^2. What centripetal force must be causing its circular motion?

$$F_c = ma_c = (2\,\text{kg})\cdot(10\,\text{m/s}^2) = 20\,\frac{\text{kg}\cdot\text{m}}{\text{s}^2} = 20\,\text{N}$$

16. (2 points) You are in an amusement park ride that lets you free fall in a seat for a few seconds, during that time you hold a ball in front of you and then let it go without throwing it. What will you see?

You will see that ball float in front of you until the ride stops free-falling.

17. (2 points) You are an astronaut in orbit around the earth and you demonstrate how a ball in front of you just floats without moving toward the center of the earth even though you and it are being pulled by the gravity of the earth. Why is that so?

Because both you and the ball are in free fall as you move around the earth. You get no closer to the earth because you are speeding around the earth fast enough to always miss hitting it.

18. (2 points) Near-earth satellites move around the earth every 90 minutes. The Moon is much farther away and goes around the earth once a month. At a special intermediate distance a satellite can go around the earth once a day. Why is that useful?

If it goes around the earth in the same direction that the earth rotates on its axis each day, it will appear to stay above the same part of the earth at all times. It can then be a communication satellite for a specific part of the earth below it.

19. (4 points) A 200 kg canon fires a 5 kg cannonball at horizontal speed of 10 m/s. How fast does the cannon recoil?

recoil momentum = cannonball momentum so $m_{\text{cannon}}v_{\text{cannon}} = m_{\text{cannonball}}v_{\text{cannonball}}$

$$(200\,\text{kg})\cdot(v_{\text{cannon}}) = (5\,\text{kg})\cdot(10\,\text{m/s}) \quad \text{so} \quad v_{\text{cannon}} = \frac{(5\,\text{kg})\cdot(10\,\text{m/s})}{200\,\text{kg}} = 0.25\,\text{m/s}$$