Answer on Question 68555, Physics, Other

Question:

8. An artificial satellite is moving in a circular orbit of radius $36000\ km$. Calculate its speed if it takes 24 hours to revolve around the Earth.

Solution:

By the definition of the speed we have:

$$v = \frac{s}{t},$$

here, $s = 2\pi r$ is the distance traveled by the satellite (the distance traveled is the circumference of the circle), t is the time that needs the satellite to travel this distance.

Then, we get:

$$v = \frac{s}{t} = \frac{2\pi \cdot 3.6 \cdot 10^7\ m}{24 \cdot 3600\ s} = 2618\ \frac{m}{s}.$$

$$v = 2618\ \frac{m}{s} \cdot \frac{1\ km}{1000\ m} \cdot \frac{3600\ s}{1\ h} = 9425\ \frac{km}{h}.$$

Answer:

$v = 2618\ \frac{m}{s} = 9425\ \frac{km}{h}.$

9. A bus travels a distance of $120\ km$ with a speed of $40\ km/h$ and returns with a speed of $30\ km/h$. Calculate the average speed for the entire journey.

Solution:

By the definition, the average speed is the total distance traveled divided by the total time:

$$v_{avg} = \frac{d_{tot}}{t_{tot}}.$$

It is obvious that the total distance is equal to

$$d_{tot} = d_1 + d_2 = 120\ km + 120\ km = 240\ km.$$

Let's first find the time that the bus needs to travel $120\ km$ at $40\ \ km/h$:

$$t_1 = \frac{d_1}{v_1} = \frac{120\ km}{40\ \frac{km}{h}} = 3\ h.$$

Similarly, we can find the time that the bus needs to travel back the same distance of $120\ km$ at $30\ \ km/h$:

$$t_2 = \frac{d_2}{v_2} = \frac{120\ km}{30\ \frac{km}{h}} = 4\ h.$$

Then, we can find the total time for the entire journey:

$$t_{tot} = t_1 + t_2 = 3\ h + 4\ h = 7\ h.$$

Finally, we can find the average speed of the bus for the entire journey:

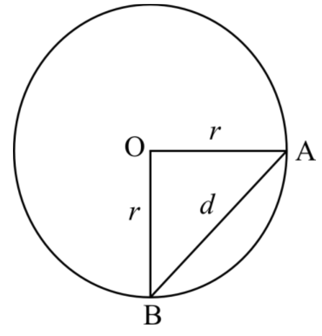
$$v_{avg} = \frac{d_{tot}}{t_{tot}} = \frac{240\ km}{7\ h} = 34.3\ \frac{km}{h}.$$

Answer:

$$v_{avg} = 34.3\ \frac{km}{h}.$$

12. A particle moves over three quarters of a circle of radius r. What is the magnitude of its displacement?

Solution:



Displacement of the particle can be defined as the shortest distance between the starting point and end point. As we can see from the picture, the displacement of the particle is the hypotenuse of the right triangle AOB. We can find it from the Pythagorean theorem:

$$d = \sqrt{OB^2 + OA^2} = \sqrt{r^2 + r^2} = \sqrt{2r^2} = r\sqrt{2}.$$

Answer:

$d = r\sqrt{2}.$

13. A bus accelerates uniformly from $54\ km/h$ to $72\ km/h$ in 10 seconds. Calculate:

(i) acceleration in m/s^2

(ii) distance covered by the bus in meters during this interval.

Solution:

(i) Let's first convert km/h to m/s:

$$v_i = 54\ \frac{km}{h} \cdot \frac{1000\ m}{1\ km} \cdot \frac{1\ h}{3600\ s} = 15\ \frac{m}{s},$$

$$v_f = 72\ \frac{km}{h} \cdot \frac{1000\ m}{1\ km} \cdot \frac{1\ h}{3600\ s} = 20\ \frac{m}{s}.$$

We can find the acceleration of the car from the kinematic equation:

$$v_f = v_i + at,$$

here, v_i is the initial velocity of the bus, v_f is the final velocity of the bus, a is the acceleration of the bus, t is the time.

Then, we get:

$$a = \frac{v_f - v_i}{t} = \frac{20\ \frac{m}{s} - 15\ \frac{m}{s}}{10\ s} = 0.5\ \frac{m}{s^2}.$$

(ii) We can find the distance covered by the bus during this interval from another kinematic equation:

$$d = \frac{v_i + v_f}{2} \cdot t = \frac{\left(15\ \frac{m}{s} + 20\ \frac{m}{s}\right)}{2} \cdot 10\ s = 175\ m.$$

Answer:

(i) $a = 0.5\ \frac{m}{s^2}$.

(ii) $d = 175\ m$.