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Physics. Grades 8-9
Demo Version

Problem 1. The bicycle rider accelerates on a straight road from the state of rest up to a speed of 14.4 km/h with an acceleration of 0.5 m/s^2. How many meters will the rider drive during the acceleration?

Solution: First, note that 14.4 km/h = 4 m/s.

Since the rider moves with uniform acceleration, the distance covered will be

$$S = \frac{v_1^2 - v_0^2}{2a} = \frac{(4m/s)^2 - (0m/s)^2}{2 \cdot 0.5m/s^2} = 16\ m,$$

where v_1 is the final velocity, $v_0 = 0$ is the initial velocity, a is the acceleration.

Answer: 16 m.

Problem 2. Two hours after the experiment, the lab technician noticed that he had forgotten to turn off the electric hot plate. During that time, the electric hot plate released 7.92 MJ of heat. Determine the voltage of the source connected to the hot plate if it produced electric current of 5A. Consider the heat loss in the connecting wires negligibly small. Give your answer in the form of a whole number of volts.

Solution: The amount of heat Q released by the electric hot plate during time t is

$$Q = UIt.$$

Then

$$U = \frac{Q}{It} = \frac{7.92 \cdot 10^6 J}{5A \cdot (2 \cdot 3600)s} = 220\ V.$$

Answer: 220 *V*.

Problem 3. In the underwater part of the ocean liner, at a depth of H = 5m, there was a breach of 40 cm^2 in the hull. Assess the minimum force required to hold the plate patch used to cover the hole from the inside. Neglect the salinity of seawater (water density ρ = 1000 kg/m^3). Free-fall acceleration g = 10 m/s^2. Give the answer in [N] accurate to the nearest whole.

Solution: To hold the plate patch, it is necessary to apply a force F equal to the force of hydrostatic pressure. The hydrostatic pressure p at the depth H is equal to $p = \rho gH$. Therefore,

$$F = pS = \rho gHS = 1000\ kg/m^3\ \cdot 10m/s^2 \cdot 5m \cdot (40 \cdot 10^{-4})m^2\ = 200N,$$

where S is the area of the hole.

Answer: 200 *N*.

Problem 4. Ghost hunters rush to a call at a maximum speed of v = 90 km/h at an address 110 km from their headquarters. The motor develops a power P = 30 kW with the efficiency of η = 30%. Estimate how many liters of gasoline a ghost hunter's car will spend during this trip. Density of gasoline ρ = 700 kg/m^3, specific heat of gasoline combustion q = 46 MJ/kg. Give your answer accurate to a tenth.

Solution: The mass of the burned fuel is $m = \rho V$. Its combustion will produce $Q = qm = q\rho V$ joules of heat. The engine running time $t = s/v$, where s = 110 km. Taking into account that

$$\eta = \frac{A}{Q} \cdot 100\% = \frac{Pt}{Q} \cdot 100\% = \frac{P \cdot \frac{s}{v}}{q\rho V} \cdot 100\%,$$

one obtains

$$V = \frac{100\%}{\eta} \cdot \frac{Ps}{q\rho v} = \frac{100\%}{30\%} \cdot \frac{(30 \cdot 10^3)W \cdot (1.1 \cdot 10^5)m}{(46 \cdot 10^6)\frac{J}{kg} \cdot \frac{700kg}{m^3} \cdot \frac{\left(\frac{9 \cdot 10^4}{3600}\right)m}{s}} \approx 0.0137m^3 = 13.7\ liters.$$

Answer: 13.7 L.

Problem 5. The theoretician Bug runs southward along the gallery with the speed of v_B = 2.5 m/s chasing a mirror moving in the same direction as Bug with the speed v_m = 2.0 m/s, the plane of the mirror remaining perpendicular to the speed of the mirror. In which direction and at what speed does the Bug's image move if viewed from the reference frame associated with the gallery? Give the answer in [m/s] accurate to the nearest tenth.

Solution: The theoretician Bug is approaching the mirror at 0.5 m/s. The image of Bug is approaching the mirror with the same speed. Therefore, in the reference frame associated with the gallery, the Bug's image velocity will be $v = v_m - v_B$ = 1.5 m/s. The image moves southwards, i.e. in the same direction as the mirror.

Answer: 1.5 m/s.