PHYS 1020: Physics of Energy

Exam 1 Examples

Basic Physics and Energy

Equations

$$Displacement = x_f - x_i \qquad Velocity = \frac{Displacement}{time} \qquad Acceleration = \frac{Change\ in\ Velocity}{time}$$

$$F = ma \qquad a_g = g = 9.8\frac{m}{s^2} \qquad Weight = F_g = mg \qquad Work = Force \times Distance$$

$$Kinetic\ Energy = \frac{1}{2} mass \times velocity^2 \qquad Potential\ Energy = mass \times g \times height$$

$$Power = \frac{Energy\ Used}{time} \rightarrow Energy = Power \times time \qquad Cost = Energy \times rate$$

Questions

1. You plan a drive from Richfield, UT (*52.6 miles* South of Ephraim) to Las Vegas, NV (*337 miles* South of Ephraim). What is the **displacement** of your drive?

2. If you need to make the trip in 4.5 hours, what should be your **speed** (velocity)?

3. As you drive onto the interstate, you accelerate from a speed of 15 *mph* to the speed you calculated in question 2. If it takes 20.0 *seconds* to reach this speed, what is your **acceleration**?

4. For the remaining questions, we'll need the velocity in *m/s* and the acceleration in m/s^2. We know that *1 mph = 0.447 m/s*, convert your answers from questions 2 and 3.

5. If your car has a mass of 1,500 *kg*, what force does your engine have on the car to make it accelerate at that rate? (Use your new value of acceleration.)

6. If your car exerts this force for a distance of 307 *m*, how much work did your car do?

7. What is the car's Kinetic Energy during this trip?

8. Your car's engine runs at a power of 20 *kW*. How much energy does your car use during this 4.5−*hour* trip?

9. If we said that the cost of gasoline is $0.85 per *kWh*, what is the cost of this trip?

Growth

Equations

$$Linear\ Growth\text{:}\ \ N = N_0 + rt \qquad\qquad Exponential\ Growth\text{:}\ \ N = N_0 e^{rt}$$

$$Doubling\ Time\text{:}\ \ t_2 = \frac{\ln(2)}{r\ (as\ decimal)} \approx \frac{70\ (time\ unit)}{r\ (as\ percentage)}$$ where the unit is in the rate.

For example, if $r = 4.7\%\ monthly$, then the time unit is months.

Questions

1. You currently have $750 in a non-interest savings account. If you add $10 each week, how much will you have in one year (52 weeks)? In 3 years?

2. You have a culture of 250 bacteria. If the bacteria grows exponentially at a rate of 2.5% daily, how much will you have after 1 week (7 days)?

3. For the culture in question 2, how much time will it take to double the quantity to 500 bacteria?

Thermodynamics

Equations

$$Specific\ Heat = mass \times constant \times (Temperature\ Change) \qquad Latent\ Heat = mass \times constant$$

$$Heat\ Supply = Heat\ to\ cold\ reservoir + Work\ done \qquad Efficiency = \frac{Work}{Heat\ Supply} = \frac{Work}{Energy\ in}$$

$$Efficiency_{max} = \frac{T_H - T_C}{T_H}$$

Questions

1. You have 1.20 kg water at room temperature (20°C). How much heat is needed to raise it to the boiling point (100°C)?
(Specific Heat constant for water = 1 *calorie per kg per °C* or 4.186 *kJ per kg per °C*)

2. You have 6.50 kg of ice at the melting point. How much heat is needed to melt it?
(Latent Heat constant for ice = 79.55 *kilocalories per kg* or 333 *kJ per kg*)

3. You have a heat engine that supplies 5,000 kWh of energy. If you measure 1,200 kWh going into the cold reservoir, how much energy is used for Work?

4. What is the efficiency of the engine in question 3?

5. If you get a nuclear reactor to run at a temperature of $900°C$, what is the peak efficiency possibly with this reactor? Assume the outside temperature is $20°C$.