

# Physics 173, Physics of Sustainable Energy

## Quiz 1, 1pm Thurs Sept 7, 2023

Each question has one correct answer.

1. Maria is riding her bicycle on a flat road at 10 mi/hr. Then she squeezes the brakes and comes to a halt. Once that process is complete, the kinetic energy of Maria and her bicycle has mostly been converted to
  - (A) gravitational potential energy
  - (B) thermal energy
  - (C) electrical energy
  - (D) nuclear energy
2. When someone says “the energy density of gasoline is about 10 Calories per gram”, what they mean is
  - (A) it takes 10 Cal of energy to extract a gram of gasoline from crude oil
  - (B) when a gram of gasoline evaporates, it gives out 10 Cal of energy
  - (C) in order for a gram of gasoline to evaporate, it must absorb 10 Cal of energy
  - (D) when a gram of gasoline is oxidized to carbon dioxide and water, it gives out 10 Cal of energy
3. Human beings are mostly made of water. Which of these is the best estimate of the volume of a typical person?
  - (A) 70 liters
  - (B) 17 liters
  - (C) 400 liters
  - (D) 270 liters
4. A two liter bottle of soda (which is mostly water) is placed in a fridge. It cools from room temperature (20 C) to 5 C. How much energy has the fridge taken from the soda?
  - (A) 860 J
  - (B) 8400 J
  - (C) 26,000 J
  - (D) 120,000 J

# Physics 173, Physics of Sustainable Energy

## Quiz 2, 1pm Thurs Sept 14, 2023

Each question has one correct answer.

1. Which of the following features of hybrid cars help them have better gas mileage than regular cars:  
(A) the battery pack is lighter than a filled fuel tank  
(B) they don't have such good acceleration  
(C) their gasoline engine always runs at maximum efficiency  
(D) they use a fuel cell to extract energy from gasoline
2. In a hydrogen-powered car, the role of the fuel cell is  
(A) converting chemical energy to electric energy  
(B) capturing the heat produced when hydrogen is burned  
(C) capturing carbon dioxide emitted by the engine  
(D) converting electric energy to kinetic energy of the car
3. Blue hydrogen is  
(A) made from natural gas, releasing  $\text{CO}_2$  in to the atmosphere  
(B) made from natural gas, producing  $\text{CO}_2$  which is stored underground  
(C) extracted from natural underground deposits of hydrogen gas  
(D) made from water using energy from low-carbon sources
4. A hybrid car's battery stores about 9kWh of energy. Estimate how far the car can travel on a fully charged battery, without using any other energy source.  
(You may use the fact that a gasoline powered car can achieve about 20 miles/gal.)  
(A) 40 miles      (B) 20 miles      (C) 12 miles      (D) 4 miles

# Physics 173, Physics of Sustainable Energy

## Quiz 3, 1pm Sept 21, 2023

Each question has one correct answer.

1. Which of the following sentences uses the correct units?  
(Note: it doesn't matter if the sentences are true or not, just whether they use the appropriate units)  
(A) The power output from a car battery when it is starting a car is about 100 kWh  
(B) The energy needed to lift a bicycle to the roof of a car is about 100 J  
(C) The power in sunlight is about 1 kJ per square meter  
(D) The energy in a bullet moving at the speed of sound is more than 100 J s<sup>-1</sup>
2. In terms of the total cost ("levelized cost") per kiloWatt-hour, which of the following is the cheapest way to provide electrical energy?  
(A) wind power  
(B) solar panels on the roofs of houses  
(C) nuclear power  
(D) coal
3. Which form of energy supplies more than 10% of the U.S.'s total power needs?  
(A) solar      (B) wind      (C) natural gas      (D) hydroelectric
4. Suppose a 1kW electric toaster oven is on for 30 minutes. Roughly how much energy is used by the oven?  
(A) 30 kWh      (B) 3.6 MJ      (C) 2 million Joules      (D) 50 Wh

# Physics 173, Physics of Sustainable Energy

## Quiz 4, 1pm Thurs Sept 28, 2023

Each question has one correct answer.

1. Which has more kinetic energy, a 1-ton car travelling at 60 mi/hr or a 4-ton truck travelling at 30 mi/hr?  
(A) the car  
(B) to give an answer more information would be needed  
(C) they have the same kinetic energy  
(D) the truck
2. Absolute zero (zero degrees Kelvin) is the temperature at which  
(A) molecules move at roughly half the usual speed of sound (760 mi/hr)  
(B) molecules fall apart into atoms  
(C) molecules have no random movement  
(D) water freezes
3. Which contains a larger amount of heat energy: one liter of water at room temperature, or two liters of ice at 0 C?  
(A) there is more heat energy in the one liter of water  
(B) there is more heat energy in the two liters of ice  
(C) they have the same amount of heat energy  
(D) to give an answer more information would be needed
4. The atomic mass of a molecule of ethanol (alcohol) is 46. What is the chemical formula for ethanol?  
(A)  $C_2 H_6$       (B)  $C_2 H_6 O$       (C)  $C H_3 O$       (D)  $C_3 H_8$

# Physics 173, Physics of Sustainable Energy

## Quiz 5, 1pm Thurs Oct 5, 2023

1. If two objects are at the same temperature then
  - (A) they each have the same total thermal energy
  - (B) you can extract useful work from the heat flow between them
  - (C) the molecules have the same average kinetic energy in each object
  - (D) the molecules move at the same speed in each object
2. Which of the following is an example of a heat engine:
  - (A) a nuclear power plant
  - (B) the air conditioning in your car
  - (C) a hydrogen fuel cell
  - (D) the electric motor in a Tesla car
3. A gasoline engine burns fuel at a temperature of 400 C, and the surrounding environment has a temperature of 20 C. What is the maximum possible efficiency of the engine?  
(A) 35%      (B) 20%      (C) 67%      (D) 56%
4. If a heat pump has a coefficient of performance equal to 3, then
  - (A) for every 1 J of work going in, 3 J of heat come out
  - (B) for every 3 J of work going in, 1 J of heat comes out
  - (C) for every 1 J of work going in, it removes 3 J of heat from the cold region
  - (D) for every 3 J of work going in, it removes 1 J of heat from the cold region

# Physics 173, Physics of Sustainable Energy

## Quiz 6, 1pm Thurs Oct 26th, 2023

1. Which of the following would change the solar constant  $F$  in our simple model of earth's climate?
  - (A) making the earth spin faster
  - (B) lowering the earth's absorption fraction
  - (C) reducing the amount of greenhouse gases in earth's atmosphere
  - (D) moving the earth closer to the sun
2. Which of the following is an example of a positive feedback loop for global warming?
  - (A) increased temperature means plants grow faster and absorb more  $\text{CO}_2$
  - (B) increasing temperature means permafrost melts and releases methane
  - (C) increasing temperature means more evaporation, so more white clouds
  - (D) increased temperature means more water vapor in the atmosphere, so more snow and bigger polar ice caps
3. The main effect of sulfur dioxide emissions from burning fossil fuels is to
  - (A) increase global warming by increasing atmospheric greenhouse gases
  - (B) increase global warming by absorbing more sunlight
  - (C) decrease global warming by creating white reflective clouds
  - (D) decrease global warming by reacting with  $\text{CO}_2$
4. According to the simple climate model we studied in class, if earth's absorption fraction  $\alpha$  increases by 4%, then earth's temperature (in Kelvin)
  - (A) goes up by 4%
  - (B) goes down by 4%
  - (C) goes up by 1%
  - (D) goes down by 2%

# Physics 173, Physics of Sustainable Energy

## Quiz 7, 1pm Thurs Nov 2nd, 2023

Each question has one correct answer.

1. If humans had not produced any greenhouse gas emissions over the last 100 years, the current global average temperature would
  - (A) be about the same now as it was in 1920
  - (B) be about 1C lower than it was in 1920
  - (C) be about 1C higher than it was in 1920
  - (D) be about the same as is actually observed today
2. Which of the following is a likely significant negative effect of global warming?
  - (A) decreased crop yields due to faster growth of weeds
  - (B) expansion of regions where solar power is plentiful
  - (C) evolution of drug-resistant bacteria
  - (D) mass migration due to changes in availability of food
3. In global energy consumption, the three main sources of energy are
  - (A) nuclear, oil, and natural gas
  - (B) oil, natural gas, and biofuels
  - (C) natural gas, oil, and coal
  - (D) coal, oil, and nuclear
4. The Antarctic ice cap weighs about 24 million gigatons. If it were to melt into the earth's oceans (area 360 million km<sup>2</sup>), how much would sea levels rise?
  - (A) 6 m
  - (B) 60 m
  - (C) 15 m
  - (D) 1.5 m

# Physics 173, Physics of Sustainable Energy

## Quiz 8, 1pm Thurs Nov 9, 2023

Each question has one correct answer.

1. Which of the following is a geoengineering approach to combating global warming?  
(A) raising more livestock which eat plants and make fertilizer  
(B) melting glaciers to expose the darker land beneath  
(C) developing crops that are resistant to fungal infestation  
(D) placing a reflective layer on large areas of desert
2. A modern oil drilling rig  
(A) can drill down no more than 1000m  
(B) can drill sideways up to 10 km  
(C) uses solar power to drive its drill  
(D) consumes more fossil fuel than it extracts from underground
3. The U.S. consumes 13 quads/year of electricity. Roughly how many 1 GW power stations are needed to meet that demand?  
(A) more than 10,000      (B) 500      (C) 5000      (D) 1500
4. The chemical formula for methanol is  $\text{CH}_3\text{OH}$ . When you burn 1 kg of methanol, how many kilograms of  $\text{CO}_2$  are produced?  
(A) 44 kg      (B) 4.4 kg      (C) 1.4 kg      (D) 0.4 kg

# Physics 173, Physics of Sustainable Energy

## Quiz 9, 1pm Thurs Nov 16, 2023

Each question has one correct answer.

1. Carbon Capture and Storage (CCS) means
  - (A) burning more expensive coal that contains only a small amount of carbon
  - (B) using environmentally friendly methods to mine and store coal
  - (C) using fossil fuels obtained by fracking rather than by traditional methods
  - (D) burning coal and burying the  $\text{CO}_2$  that is produced
2. Geothermal electricity
  - (A) uses heat from earth's interior to make steam to drive turbines
  - (B) produces as much GHG emission as natural gas
  - (C) uses heat pumps to transfer earth's heat to buildings
  - (D) turns gravitational potential energy of water into electrical energy
3. A wind turbine has blades that are 10 m long. In a 30 mi/hr wind, over a duration of 1 second roughly what volume of air passes through the circular area swept by the blades?
  - (A)  $10,000 \text{ m}^3$
  - (B)  $4000 \text{ m}^3$
  - (C)  $2000 \text{ m}^3$
  - (D)  $1000 \text{ m}^3$
4. In full direct sunlight, a low-cost solar photovoltaic panel, of size 1 m by 2 m is expected to yield what electric power?
  - (A) 75 W
  - (B) 2000 W
  - (C) 150 W
  - (D) 300 W

# Physics 173, Physics of Sustainable Energy

## Quiz 10, 1pm Thurs Nov 30, 2023

Each question has one correct answer.

1. Hydroelectric power stations
  - (A) only provide power intermittently
  - (B) are inefficient because water has to be pumped into the reservoir
  - (C) can provide power near any large population center
  - (D) convert gravitational potential energy into electrical energy
2. Molten salt energy storage is
  - (A) a form of heat pump
  - (B) simple technology that can be used almost anywhere
  - (C) more efficient (energy out vs. energy in) than gravity energy storage
  - (D) less energy-dense than gravity energy storage
3. Roughly how much energy would you have to store in order to power a city of 1 million people (300,000 houses) for a week?
  - (A) 10 GWh
  - (B) 1 GWh
  - (C) 50 GWh
  - (D) 1 TWh
4. If a flywheel has an energy density of 200 J/g, roughly how fast are the internal parts traveling?
  - (A) 600 m/s
  - (B) 300 m/s
  - (C) 600 mi/hr
  - (D) 300 mi/hr

# Physics 173, Physics of Sustainable Energy

## Quiz 11, 1pm Thurs Dec 7, 2023

Each question has one correct answer.

1. Respiration is
  - (A) the process by which plants make sugars from  $\text{CO}_2$  in the air
  - (B) the conversion of plant materials to coal, oil, or natural gas
  - (C) a process by which sugars are oxidized to release  $\text{CO}_2$
  - (D) a process that only occurs in plants, not in animals
2. Gold has an unstable isotope,  $^{173}_{79}\text{Au}$ , that decays by emitting an alpha particle. What nucleus is produced in the decay?
  - (A) some isotope of tellurium (Tl)
  - (B) some isotope of iridium (Ir)
  - (C) some isotope of mercury (Hg)
  - (D) a different isotope of gold
3. Suppose a nuclear weapon contains 5 kg of  $^{235}\text{U}$ . When it detonates, 7% of the  $^{235}\text{U}$  undergoes fission. Estimate the energy of the explosion in terms of the equivalent mass of TNT.
  - (A) 7 kiloton
  - (B) 7 Megaton
  - (C) 2 kiloton
  - (D) 2 Megaton
4. Suppose a viral infection is spreading through the population. If a person becomes infected, then over the next week they infect two more people. If you start off with one infected person in week zero, roughly how long will it take to infect 100,000 people?
  - (A) 2 years
  - (B) 4 weeks
  - (C) 2 weeks
  - (D) 4 months