

(Take-Home)  
**Exam I**

**Due – at 8<sup>30</sup> am on Wednesday, November 7th, 2018.**

Instructions:

This exam problem is to be completed **individually** without assistance from any other person.

Although you may complete this exam under *limited* open-book conditions, you must utilize the resource material that is posted on the instructor's webpage at:

*<http://www.profwagner.com/2020.htm>*

and/or your lecture notes as your primary references.

Note that “limited” open-book conditions means that you may also utilize any published textbooks or reference material, including on-line publications, provided that they are “web publications” of textbooks or other material.

Forums or other “on-line” resources that individuals may utilize to post and/or answer specific questions may not be utilized when completing this exam.

You must sign the following affirmation before submitting your completed exam:

“I do affirm that all of the work contained in this exam booklet is my own, that I didn't not utilize any resources while completing this exam except those allowed (as stated above), and that no assistance was provided to me by any other person.”

Sign Name: \_\_\_\_\_

Print Name: \_\_\_\_\_

\*\*\*\*\* *Be sure to read and sign the statement provided on the first page of this exam booklet* \*\*\*\*\*

**Instructions:** You must show all of your work when completing the numerical problems, including both the formulas utilized during their solution and the numbers plugged in to those formulas. No credit will be given for illegible or illogical work, or for final answers that are not justified by the work shown. Maintain at least three significant digits of accuracy when completing the numerical problems. Place all final answers in the spaces provided.

If you require any “constants” in order to solve the problems, utilize the values provided for those constants in the course PowerPoints before looking up the value from any other resources. Either way, be sure the values for the constants that you utilized are clearly shown in your work.

**Problem #1)** Assuming an energy price of **\$0.126/kWh**, determine the **total cost** of operating a **1500W** electric space heater each day, for an average of **12h/day**, during the entire month of December. Round your answer to the nearest penny (i.e. – hundredth of a dollar)

Total Cost = \$ \_\_\_\_\_

**Problem #2)** Determine the amount of heat **energy** (in joules) required to raise the temperature of **250mL** of **water** from **52°F** to **66°F**. Round your answer to the nearest whole number of joules.

Energy required = \_\_\_\_\_ (J)

**Problem #3)** Assuming that a **natural-gas burning furnace** is **86% efficient**, determine the number of **joules** of usable heat that the furnace will produce if it consumes (burns) **18ft<sup>3</sup>** of natural gas.

Heat produced = \_\_\_\_\_ (J)

**Multiple Choice – Write the letter relating to the correct or best response to each of the following statements in the blank provided before each statement.**

\_\_\_\_\_ **“Energy”** is best defined as:

- A) The amount of charge stored in a battery.
- B) The ability or capacity to do work.
- C) The rate at which a moving object is brought to a complete stop.
- D) The rate at which power is either produced or consumed by a device.
- E) All of the above choices (A, B, C, D) are correct

\_\_\_\_\_ **“Thermal Energy”**:

- A) Can be defined as the internal energy of a material.
- B) Is associated with the random motion of particles in a substance at an atomic scale.
- C) Is often characterized in terms of temperature.
- D) All of the above choices (A, B, C) are correct.

\_\_\_\_\_ **“Potential Energy”** is best defined as:

- A) The amount of energy that an object is able to store.
- B) The amount of electric energy provided by a voltage potential.
- C) The energy contained in an object (or material) that is associated with the object’s position in a force field.
- D) All of the above choices (A, B, C) are correct.

\_\_\_\_\_ **“Renewable Energy”** is best defined as:

- A) Energy derived from resources that are naturally replenished on a human timescale.
- B) An energy source that can be renewed by taking the depleted source to a recycling plant.
- C) Any energy derived from resources that do not result in the emission of green-house gasses.
- D) All of the above choices (A, B, C) are correct.

\_\_\_\_\_ **“Insolation”** is best defined as:

- A) The average amount of sunlight that shines on a given surface during an entire day.
- B) A measure of the solar energy that is incident on a specified area over a set period of time.
- C) The rate at which the energy from the Sun is able to penetrate through the Earth’s atmosphere.
- D) All of the above choices (A, B, C) are correct.

\_\_\_\_\_ A typical **single-layer, silicon Solar Cell**:

- A) Utilizes a p-type material that can be created by doping the silicon with boron.
- B) Is only able to convert sunlight having wavelengths shorter than 1120nm into electric energy.
- C) Might have an efficiency around 10-12%.
- D) All of the above choices (A, B, C) are correct.

\_\_\_\_\_ An **Inverter**:

- A) Is utilized to convert the DC voltages developed by solar cells into AC voltages.
- B) Is utilized to invert or tilt a solar panel as the sun travels across the sky during the daytime.
- C) Is utilized to reverse (invert) the energy produced by a solar cell so it can be utilized at night.
- D) All of the above choices (A, B, C) are correct.

**True/False** – Specify whether each of the statements are **TRUE** or **FALSE**. (Do **NOT** write only “T” or “F”)

Do **NOT** write only “T” or “F” in the blanks. Instead, **PRINT** either the word “**TRUE**” or “**FALSE**”.

- \_\_\_\_\_ A **Grid-Connected Photovoltaic System** is a system in which the individual solar cells are connected in series to form solar modules, which in-turn are connected together in parallel, the entire combination of which forms the overall grid-type structure of a solar panel.
- \_\_\_\_\_ According to the US Energy Information Administration, **Renewable Energy** sources accounted for less than 10% of the total primary energy production in the US in 2017.
- \_\_\_\_\_ **Concentrating Solar Power** plants often store some of the heat energy collected from the Sun in large storage vessels that contain molten salt, enabling the plants to produce electric energy for a duration of time after the sun sets.
- \_\_\_\_\_ A **Joule** is equal to the amount of energy transferred to an object when a force of one pound acts on that object in the direction of motion through a distance of one foot. ( $1 \text{ J} \equiv 1 \text{ lb}\cdot\text{ft}$ )
- \_\_\_\_\_ Unlike the heliostats (flat mirrors) utilized in Power Tower systems that have to pivot on both axes (N-S and E-W) in order to track the sun, the **Parabolic Reflectors** utilized for Linear Collector systems only have to pivot on one axis (E-W) if they are properly aligned.
- \_\_\_\_\_ The **Thermal Mass** utilized within a passive solar heating system refers to the materials that store the heat produced by sunlight for use during the absence of sunlight.
- \_\_\_\_\_ When properly aligned, Parabolic Dish / Engine type concentrating solar power systems only focus the **direct-path light** (energy) from the Sun onto their thermal receivers.
- \_\_\_\_\_ **Current** flows externally from the n-type region to the p-type region of solar cells when the cells are exposed to sunlight and producing electric energy.
- \_\_\_\_\_ The **AM2 Solar Condition** exists when the energy from the Sun arrives at the surface of the Earth at an angle of roughly  $60^\circ$  when measured from the zenith position, or when the Sun is at an angle of roughly  $30^\circ$  above the horizon.
- \_\_\_\_\_ **Solar, Tidal, and Geothermal Energy** are considered the three primary types of renewable energy because the energy associated with each of these three types is derived from a fundamentally different source.
- \_\_\_\_\_ One **Nutritional Calorie** (Cal) is equivalent to roughly 4200 joules of energy.

**Do Not Write Below This Line**

---

1) \_\_\_\_\_ /15 2) \_\_\_\_\_ /15 3) \_\_\_\_\_ /15 MC) \_\_\_\_\_ /25 TF) \_\_\_\_\_ /30 Total) \_\_\_\_\_ /100