Instructions: This test is divided into two parts. Part A is entitled short answer questions where you are to pick the best word, phrase or choice of answers which best answers or, in some cases, defines the statement. Part B is entitled longer answer questions. Make your answer clear and concise. If you need more room turn over the test paper and continue on the back, but please write \"over\" on the test. For problems, it is the procedure that will be checked, not only the answer so please try to make it clear. Be sure to include all units in answering problems (such as we've done in class). Point weighing is indicated in parentheses. So for this, the first test of the summer energy course, Good Luck!

A. Short Answer Questions

1. (6) Choose from the following physical quantities which we have discussed - length, area, volume, time, mass, force, speed, acceleration - to answer the following:

   a) A "push" or a "pull" is a ___.
   b) A measure of the amount of surface (2D) is ___.
   c) How long something is, is a one-dimensional quantity called ___.
   d) How fast an object is moving is ___.
   e) The quantity of matter contained by an object is ___.
   f) Weight is a ___.

2. (12) Choose from the list of physical quantities listed in question 1 to identify the quantities listed below taken from various problems. Note: Some quantities may be used more than once.

   - Speed
     a) 4.59 m/s
     b) 2.1 N
     c) 9.73 m²
     d) 8.22 m/s²
   - Mass
     e) 9 kg
     f) 8.3 ft
     g) 8.7 ft/s/s
     h) 9.2 ft²
   - Force
     i) 7.4 pounds
     j) 1.35 m
     k) 7.32 mi
     l) 3.21 min

3. (3) Write the following in scientific notation:

   a) 59,300,000 m
   b) 65 N
   c) \( \frac{5.903 \times 10^{-7}}{} \)

4. (3) Write the following in ordinary notation.

   a) 5.22 \times 10^3 m
   b) 5.22 \times 10^4 m
   c) 5.05 \times 10^6 m
5. (1) What is the doubling time in years if oil consumption increases at a mere 7% per year?

6. (1) The time that it takes for a finite resource to be completely depleted when being used at a constant rate of growth is called _?_.

7. (2) The prefix "milli" as applied to milliseconds (ms) means _?_.

8. (2) An object travels 60 m in 10 s. Its average speed is _?_.

\[ \text{speed} = \frac{\text{dist.}}{\text{Time}} = \frac{60 \text{m}}{10 \text{s}} = 6 \text{m/s} \]

9. (2) A box measuring 2.0 ft by 3.0 ft by 5.0 ft contains _?_ ft³ or equivalently, it would contain _?_ in³.

\[ \text{Vol} = (2 \text{ft})(3 \text{ft})(6 \text{ft}) = 36 \text{ft³} = 36 \times 12^3 \text{in³} = 36 \times 1,728 \text{in³} = 62,312 \text{in³} \]

10. (2) An object speeds up from rest to 24 m/s in 4.0 s. Its acceleration is _?_.

\[ \text{acc} = \frac{\text{change in speed}}{\text{time}} = \frac{24 \text{m/s} - 0}{4 \text{s}} = 6 \text{m/s}^2 \]

11. (2) A wall measures 6.0 m by 7.0 m. The area of the wall is _?_ m² or it is also _?_ cm².

\[ \text{Area} = (600 \text{cm})(700 \text{cm}) = 420,000 \text{cm}² = 4.2 \times 10^4 \text{cm}² \]

12. (2) If a car travels 60 ft in 4.0 s, how far will it travel in 12 s?

\[ \text{rate} = \frac{180 \text{ft}}{12 \text{s}} = 15 \text{ft/s} \]

13. (2) If 1.6 km = 1.00 mile, a distance of 20 mi is equal to _?_ km.

\[ 20 \text{mi} = (20 \text{mi})(1728 \text{ft/mi})(0.621371 \text{km/mi}) = 32.21371 \text{km} \approx 32 \text{km} \]

14. (2) With the rate of consumption of a resource growing at the rate of 14% per year, the consumption in one-half decade (5 years) very nearly equals the total of all previous consumption (True, False).

\[ \text{true} \]

15. (2) President Carter in the year 1977 suggested that the United States increase the use of its domestic coal supply by 5% per year. Even if one uses the highest estimate of reserves of coal in the United States, the entire supply of coal would be used up in about (a) 10,000 years (b) 5,000 years (c) 3,000 years (d) 1000 years (e) 500 years (f) 100 years (g) 50 years

\[ \text{200 Years} \]

16. (2) If the doubling time of bacteria in a bottle were 3 min and the bottle was completely full at 12 min, at what time would the bottle be 1/8 full?

\[ 1 \text{cm}³ = 1,000,000 \text{cm}³ \]

\[ \frac{1}{8} \text{ of } 10,000,000 \text{ cm}³ = 1,250,000 \text{ cm}³ \]

17. (2) Ten cubic meters equals _?_ cubic centimeters.

\[ 10,000,000 \text{ cm}³ = 10 \text{ m}³ \]

18. (1) If an object is moving at a constant speed (with no increase or decrease in that speed), then the acceleration of that object is _?_.

\[ 0 \]

21. (2) Suppose that Country X is experiencing inflation of 70% per year. Find the cost of a loaf of bread in that country four years from now if it cost $5 today. (Note: Treat the unit of currency of Country X as $.)

\[ \text{Now } $5 \]

\[ \frac{70}{70} = 1 \text{year} \]

\[ \frac{1}{2} \text{ Full} \]

\[ 11:57 \frac{1}{2} \text{ Full} \]

\[ 11:51 \frac{1}{8} \text{ Full} \]

\[ 11:54 \frac{1}{4} \text{ Full} \]

\[ 11:50 \frac{1}{2} \text{ Full} \]

B. Longer Answer Questions

1. (4) A car travels a distance of 100 ft in 5 sec.
   (a) Find the average speed of the car:

   \[ \text{speed} = \frac{100 \text{ft}}{5 \text{s}} = 20 \text{ft/s} \]

   (b) Find the distance traveled:

   (i) After 1 sec: 20 ft
   (ii) After 2 sec: 40 ft
   (iii) After 4 sec: 80 ft
2. (4) Albert Bartlett discusses the “forgotten fundamentals” in his classic article *Forgotten Fundamentals of the Energy Crisis.* List two of these “forgotten fundamentals” that Bartlett discusses?

1. Unlimited “exponential” growth cannot be sustained.
2. People do not take into account the dramatic effect of exponential growth.
3. Any of major effects listed in question #15 below.

3 (5) Current world population growth is about 7 billion people. Thirty five years ago, the world growth rate was about 1.9%. Today, the world growth rate is about 1.1%. For each of the two growth rates, calculate how many years it would take for the world population to become 28 billion people.

\[
\text{DT} = \frac{70}{1.9} = 37 \text{ years} \quad \text{DT} = \frac{70}{1.1} = 64 \text{ years}
\]

Start: 7B people.

37 yrs: 14B

64 yrs: 18B

4 (4) Define exponential growth and give three examples of exponential growth.

Exponential growth is a fixed rate every year and that growth is added to the original sample and in turn produces more growth is exponential growth. Examples: Bacterial growth in a fertile environment, disease epidemics at start, inflation, money in a savings account, world oil usage prior to 1973.

5. (4) Discuss Bartlett’s example of the mathematician, the king and the grains of wheat on the chessboard, and list two major points that Bartlett was attempting to make.

Place 1 grain on square 1, double to place 2 grain on square 2, double again to place 4 grains on square 3, etc. for all 64 squares (or 63 doublings).

1. Doubling (exponential growth) leads to enormous numbers very quickly.
2. The number of grains required for the next square equals (approximately) the sum of all grains used previously.
6. (4) Use two of the three methods discussed in class to determine the number of cubic inches in one cubic yard. (Hint: 1 yd = 3 ft and 1 ft = 12 in)

\[ \text{Volume} = \frac{36 \text{ in}^3}{\text{layer}} \times \frac{36 \text{ layers}}{1 \text{ yd}} = 46,656 \text{ in}^3 \]

7. (6) Convert 30 km/hr to in/s.

\[ \frac{30 \text{ km}}{1 \text{ hr}} = \left( \frac{30 \text{ km}}{1 \text{ hr}} \right) \left( \frac{1 \text{ mi}}{1.609 \text{ km}} \right) \left( \frac{5280 \text{ ft}}{1 \text{ mi}} \right) \left( \frac{1 \text{ hr}}{60 \text{ min}} \right) \left( \frac{1 \text{ min}}{60 \text{ s}} \right) = 330 \text{ in/s} \]

\[ \frac{30 \text{ km}}{1 \text{ hr}} = \left( \frac{30 \text{ km}}{1 \text{ hr}} \right) \left( \frac{1000 \text{ m}}{1 \text{ km}} \right) \left( \frac{1 \text{ m}}{1 \text{ in}} \right) \left( \frac{2.54 \text{ cm}}{1 \text{ in}} \right) \left( \frac{2.54 \text{ cm}}{1 \text{ in}} \right) \left( \frac{1 \text{ min}}{60 \text{ s}} \right) \left( \frac{60 \text{ s}}{1 \text{ min}} \right) \left( \frac{1 \text{ min}}{60 \text{ s}} \right) \left( \frac{1 \text{ min}}{60 \text{ s}} \right) = 328 \text{ in/s} \]

NOTE: 5280 ft = 1 mile
2.54 cm = 1 in
12 in = 1 ft
1.6 km = 1 mile
60 s = 1 min
60 min = 1 hr

8. (6) Fill in the diagram used by Bartlett. What is it and discuss its significance. (Be sure to include in your discussion the percent rate of growth and the doubling time.)

The diagram illustrates the use of WORLD OIL by using area. World oil prior to 1923 increased at 7.0%/year. This gives a doubling time of

\[ DT = \frac{70}{7} = 10 \text{ years} \]

Hence every 10 years, the amount of world oil usage would have doubled. We would have "run out" by the turn of the century.

This amount of oil would need to be discovered for 2000-2010 to maintain the 7.0% growth rate.
9. Discuss the following from the viewpoint of the text:

   (4) Gross Domestic Product (GDP). In your discussion be sure to mention which country enjoys the greatest GDP per capita with a minimal expenditure of energy per capita. How might "standard of living" be measured?

   The Gross Domestic Product (GDP) is the total dollar sum of goods and services provided by a country each year. If the GDP is divided by the number of people in the country, then that gives a measure of the amount each person has - i.e., standard of living (GDP/capita). According to the text, Japan, Norway, and most European countries have approximately the same GDP/capita but use only about half the energy as do the energy "hogs" of the United States and Canada.

   (2) Energy production and energy consumption of the United States. List an approximate energy usage of coal, natural gas, oil, nuclear and renewables.

   Both energy production and consumption of the United States have tended upward except for a couple bumps during the Arab oil embargoes of 1973 and 1979. The approximate percentage of usage is: coal, a little less than 25%; natural gas, about 25%; oil, a little more than 33%; nuclear, around 8%; renewables, less.

   (2) Geothermal

   Utilizing the heat from the earth to produce steam to produce electrical energy.

   (2) Hydroelectric

   Utilizing the GEPE of dams to produce electrical energy.

   (2) Renewable and nonrenewable energy

   Nonrenewable energy includes the fossil fuels that one day will run out. These include coal, oil, natural gas.

   Renewable energy includes solar, wind, biomass, and usually geothermal. Secret number: ____________ (1 to 4 digit number)