Name _____ **2024 Rallye Glenwood Springs Tour** Time Out _____

Tour Class _____ **Tie-Breaker Answers** Time In _____

Tie breaker questions are used to determine a winner in the event of a tie. They are not extra credit questions. In the event of a tie and two or more parties answer the tie breaker questions correctly, the Tour Master will toss a coin or use some other nefarious method to determine the winner. You will have 10 minutes to complete the questions. Tie breakers turned in late will not be counted.

1. Congratulations, you successfully launched a GPS spacecraft into a circular, equatorial orbit 205km above the surface of the earth.

    a. (10 points) How long does it take to make one orbit? State your answer in hours to one significant digit using the bankers' rounding rule. Show all work.

    - There are 3 ways to arrive at the correct answer. You can do it the hard way by using the equations provided to you in the "Totally Useless Information You Learned in School" sheet contained in your tour envelope. Here's that solution:

      The orbital period can be calculated using the equation

      $$T = 2\pi r\sqrt{\frac{r}{gR_e^2}} \qquad \text{where} \quad r = R_e + h$$

      where $R_e = 6378\,\text{km}$ is the earth's radius, r is the satellites distance from the earth's center and $h = 205\,\text{km}$ is the satellite's orbital altitude, and $g = 9.81 m/s^2$ is the gravitational acceleration. With these given values the orbital period is

      $$T_{orbit} = 5312.5s = 1.4757h$$

      The correct answer is 1.5 hours

    - Or you could have remembered what your read in the "Did you know" paragraph contained in the tour package:

      A spacecraft in a circular, equatorial orbit of 205 km has a velocity relative to the earth of approximately 17,000 miles/hr and circles the earth about every hour and a half.

    - Or you could have read the welcome letter contained in your tour envelope: *And by the way, the answer to tie-breaker question 1a. is one and a half hours.*

b. (10 points) What is the velocity of this spacecraft relative to the surface of the earth? State your answer in miles per hour. Show all work.

- There are 2 ways to arrive at the correct answer. Again, you can do it the hard way by using the equations provided to you in the "Totally Useless Information You Learned in School" sheet contained in your tour envelope. Here's that solution:

$$v = \sqrt{\frac{gR_e^2}{r}} \quad \text{or} \quad T = \frac{2\pi r}{v} \Leftrightarrow v = \frac{2\pi r}{T}$$

v = (2)(3.14)(6378+205) / 5312.5 = 7.78 km/s

*7.78 km/s * 0.62 mile/1 km * 3600 sec/1 hr = 17,365 miles/hr*

The correct answer is about 17,000 miles/hr

- Or you could have remembered what your read in the "Did you know" paragraph contained in the tour package:

A spacecraft in a circular, equatorial orbit of 205 km has a velocity relative to the earth of approximately 17,000 miles/hr and circles the earth about every hour and a half.

2. (10 points) What is the wavelength of US GPS signal operating in the L1 frequency band (1575 MHz)? State your answer in centimeters to zero significant digits (nothing after the decimal point) using the banker's rounding rule. Show all work.

- From the "Totally Useless Things You Learned in School" sheet contained in your tour envelope,

Wavelength = Speed of Light / Frequency, or $\lambda = c / f$. $c = 3\text{x}10^8$ meters / sec

λ = (3x10^8 meters / sec) / (1575x10^6 / sec) * 100 cm/meter = 19 cm

3. (2 points) What two things must a new student entering the Colorado School of Mines have in order complete the M Climb?
   a. **A 10-pound rock and,**
   b. **A hard hat**

4. (1 Point) Does the Richta Competitor App store your personal information? Circle one.

   Yes

   No

5. (5 points) The diameter of a standard Coats & Clarks All Purpose Thread spool is 1 inch. To calculate the circumference, you multiply the diameter of a circle times 3.14 (pi) which gives 3.14 inches/revolution. 100, 250 and 500 yards are the most common sizes of spools for consumer use. Using the 100-yard length for example, 100 yards X 36 inches/yard = 3600 inches of thread/spool. (3600 inches/spool)/(3.14 inches/revolution) yields 1150 revolutions/spool. Based on experience, an average 100-yard spool has 10 winding layers/spool. (1150 revolutions/spool)/10 layers per spool yields 115 revolutions per layer.

   Question: What is the difference in length measured in yards between a 100-yard and 250-yard spool of Coats & Clarks All Purpose Thread?

   250 – 100 = 150 Yards

6. (5 points) Here are some data you encountered during the tour:

Elevation of Georgetown	8519
Elevation of Eisenhower tunnel	11013
Elevation of Silver Plume is	9118
Featured car year model	1974
Summit County Established	1861

What is the sum of the values listed above? Circle the most correct answer.

A. This is a nonsensical question *(see the definition of nonsensical in the "Totally Useless Things You Learned in School" sheet)*
B. 32485
C. A and B
D. None of the above