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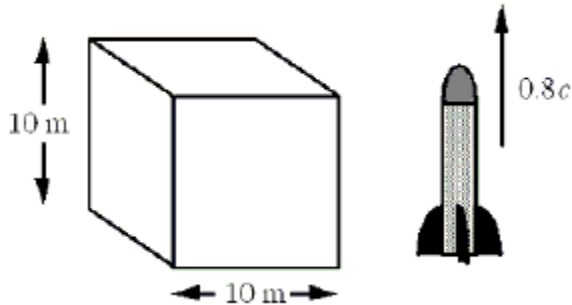
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**Question 1**

2 / 2 points

A cubic asteroid with proper side length 10.0 m is stationary in an inertial reference frame S. A rocket ship moves along one side of the asteroid as shown in the figure with speed  $0.80c$  relative to frame S. An astronaut in the rocket ship measures the volume of the asteroid. What volume does the astronaut measure?



- a) 1000 m<sup>3</sup>
- b) 600 m<sup>3</sup>
- c) 360 m<sup>3</sup>
- d) 300 m<sup>3</sup>
- e) 220 m<sup>3</sup>

**Question 2**

2 / 2 points

The starship *Enterprise* approaches the planet Risa at a speed of  $0.8c$  relative to the planet. On the way, it overtakes the intergalactic freighter *Astra*. The relative speed of the two ships as measured by the navigator on the *Enterprise* is  $0.5c$ . At what speed is *Astra* approaching the planet?

- a)  $0.92c$
- b)  $0.3c$
- c)  $0.6c$
- d)  $0.99c$
- e)  $0.5c$

**Question 3**

2 / 2 points

Mars rotates about its axis once every 88 642 s. A spacecraft comes into the solar system and heads directly toward Mars at a speed of  $0.800c$ . What is the rotational period of Mars according to the beings on the spaceship?

- a) 53 100 s
- b) 88 600 s
- c) 181 000 s
- d) 148 000 s
- e) 105 000 s

**Question 4**

2 / 2 points

The starship *Enterprise* approaches the Klingon home world with speed  $0.6c$  relative to the planet. To announce its arrival, the *Enterprise* sends a message in a projectile that travels toward the planet with

speed  $0.4c$  relative to the *Enterprise*. At what speed does a Klingon at the surface of the planet see the projectile approach?

- a)  $0.2c$
- b)  $0.5c$
- c)  $0.4c$
- d)  $0.8c$
- e)  $0.6c$

**Question 5**

2 / 2 points

Which one of the following systems would constitute an inertial reference frame?

- a) a rocket undergoing uniform acceleration
- b) a weather balloon descending at constant velocity
- c) a roller coaster traveling around a corkscrew turn at constant speed
- d) a rotating merry-go-round
- e) an orbiting space station

**Question 6**

2 / 2 points

A spaceship leaves our solar system at a constant speed of  $0.920c$  and travels to a point in the Andromeda galaxy. According to astronomers in an inertial reference frame on Earth, the distance to the galaxy is  $2.081 \times 10^{22}$  m. What distance does the crew on the ship measure on its journey?

- a)  $8.16 \times 10^{21}$  m
- b)  $1.91 \times 10^{22}$  m
- c)  $9.07 \times 10^{21}$  m
- d)  $4.77 \times 10^{22}$  m
- e)  $9.85 \times 10^{21}$  m

**Question 7**

2 / 2 points

Spaceship **A** travels at  $0.400c$  relative to an earth observer. According to the same observer, spaceship **A** overtakes a slower moving spaceship **B** that moves in the same direction. The captain of **B** sees **A** pass her ship at  $0.114c$ . Determine the speed of **B** relative to the earth observer.

- a)  $0.625c$
- b)  $0.100c$
- c)  $0.214c$
- d)  $0.700c$
- e)  $0.300c$

**Question 8**

2 / 2 points

Calculate the ratio of the relativistic kinetic energy to the classical kinetic energy,  $KE_{\text{rel}}/KE_{\text{class}}$ , for an electron (mass =  $9.109 \times 10^{-31}$  kg) moving with a constant speed of  $0.75c$ .

- a) 1.6
- b) 1.8
- c) 1.4
- d) 0.74
- e) 0.56

**Question 9**

2 / 2 points

Which one of the following statements concerning the *proper length* of a meter stick is true?

- a) The proper length is always one meter.
- b) The proper length depends upon the reference frame in which it is measured.
- c) The proper length is the length measured by an observer who is moving with respect to the meter

stick.

- d) The proper length depends upon the speed of the observer.
- e) The proper length depends upon the acceleration of the observer.

**Question 10**

2 / 2 points

Complete the following statement: To measure the proper length of an object moving relative to the surface of the earth, one must note the coordinates of points on the front and back ends

- a) at the same time with respect to a clock on the moving object.
- b) at different times with respect to a clock on the moving object.
- c) at the same time with respect to a clock at rest on the earth.
- d) at different times with respect to a clock at rest on the earth.
- e) at the same time with respect to a clock moving at the same speed on the surface of the earth.