

Physics Learning Activity

November 13, 2012

Name:

Student Number:

Bamfield Number:

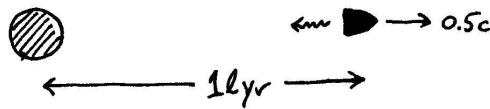
Questions 1-9: Multiple Choice: 2 point each

Questions 10-12: Show your work: 20 points total

Multiple choice answers:

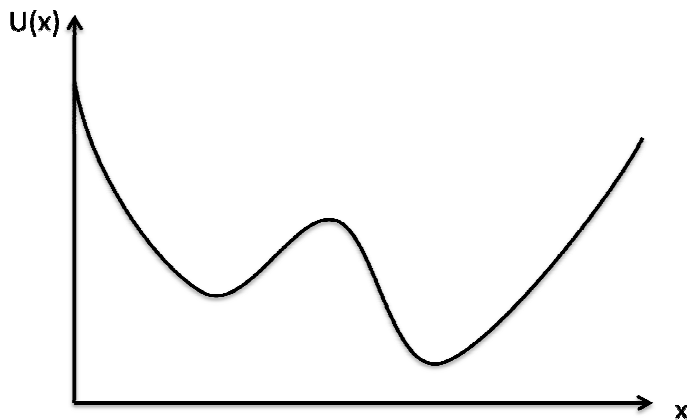
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#9	

Formula sheet at the back (you can remove it)



Question 1: A rocket traveling at $0.5c$ turns on its lights when it reaches a distance of 1 light year away from the Earth (in Earth's frame). How long does the light from the rocket take to reach Earth (in Earth's frame)?

- A) one year
- B) less than one year
- C) more than one year



Question 2: The graph above shows the potential energy of an object for various possible positions along the x direction. For how many positions x would the force on the object be zero?

- A) 0
- B) 1
- C) 2
- D) 3
- E) 4

Question 3: A new kind of particle is produced in a particle accelerator. In the experiment the new particles are always produced traveling at $v = 0.8c$, and are observed to decay after they have traveled a distance of 3 meters on average. We can conclude that the half life of the new particle is closest to

- A) 0.6×10^{-8} seconds
- B) 0.8×10^{-8} seconds
- C) 1.0×10^{-8} seconds
- D) 1.25×10^{-8} seconds
- E) 1.67×10^{-8} seconds



Question 4: A bullet collides with a block on a frictionless table and sticks inside the block. In this collision, which quantities are conserved for the system of bullet and block (ignoring effects related to the air)?

- A) Momentum, mechanical energy, and total energy
- B) Momentum and total energy but not mechanical energy
- C) Mechanical energy and total energy but not momentum
- D) Only momentum
- E) Only total energy

Question 5: The mass of a water molecule is:

- A) less than the mass of an oxygen atom plus two hydrogen atoms
- B) equal to the mass of an oxygen atom plus two hydrogen atoms
- C) greater than the mass of an oxygen atom plus two hydrogen atoms

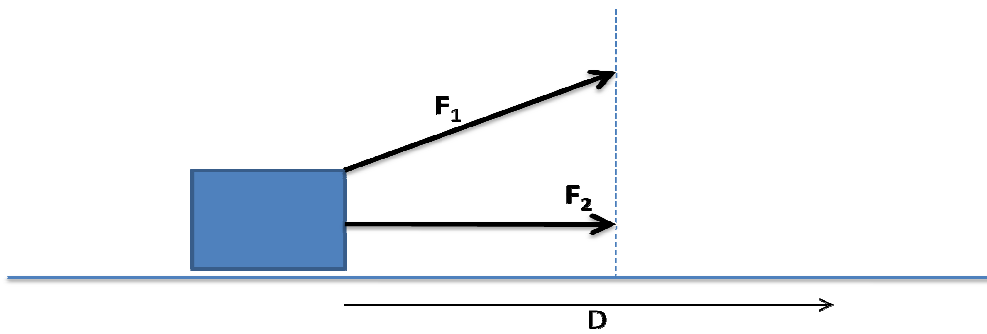
Question 6: A distant supernova explodes. In the frame of reference of the Earth, the explosion is simultaneous with the start of the Science One Learning Activity. In the frame of reference of a rocket travelling at speed $0.5c$ from Earth towards the supernova,

- A) the supernova explodes after the Science One Learning Activity begins.
- B) the supernova explodes before the Science One Learning Activity begins.
- C) the supernova explodes at the same time as the Science One Learning Activity begins.
- D) the answer could be A,B, or C depending on the location of the rocket.

Question 7: In order to make the GPS (global positioning system) work correctly, engineers make the clocks on the orbiting satellites run at a different rate from clocks on Earth so that they appear to be ticking at the same rate as the Earth clocks. In order for this to work, the engineers should make the orbiting clocks run

- A) Faster than the clocks on Earth
- B) Slower than the clocks on Earth

(ignore effects related to the rotation of the Earth and to general relativity)

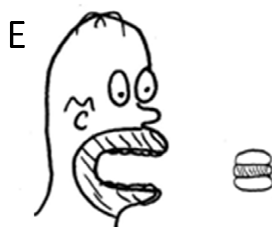
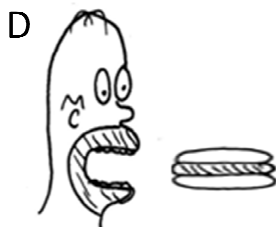


Question 8: A block is pulled a distance D across a frictionless surface using either the constant force F_1 or the constant force F_2 . The work done on the block would be

- A) greater for the force F_1
- B) greater for the force F_2
- C) the same nonzero value in either case
- D) equal to zero in either case



Question 9: Homer Simpson would like to eat a large hot dog in one bite, but finds that the distance between the front and back of his mouth is less than the length of the hot dog. Based on his knowledge of Einstein's theory of Special Relativity, Homer decides to fire the hot dog towards his mouth at a relativistic speed to take advantage of length contraction. If the picture at the left shows this scenario in Homer's frame of reference, which of the other pictures best represents the scenario in the hot dog's frame of reference?



Question 10:

For a physics demo, Mark (mass 75kg) brings in a pogo stick with a spring on the bottom that has a normal length of 30cm. Mark stands with the pogo stick at the edge of a 1m high table and jumps upward off the table. If his vertical speed is 2m/s when the bottom of the spring leaves the table and the spring compresses to 10cm when Mark hits the ground (at the lowest point of his bounce), what is the spring constant? *(ignore the pogo stick's mass and assume Mark's body position stays constant)*

(8 points)

Question 11:

A space probe designed to observe the interstellar medium is sent from Earth at velocity $v = (3/5)c$. The probe is programmed to take data and transmit it back to Earth using a light signal after 1 year has passed on the probe's clock.

a) How long after the probe leaves Earth should astronomers expect to receive the data transmission from the probe?

(5 points)

b) In the frame of the probe, what does the probe's clock read when this data signal is received back on Earth, and what is the position of the Earth in the frame of the probe when this happens?

(3 points)

BEFORE:



AFTER:



Question 12: A particle of mass M traveling at $u=4/5c$ decays into two particles of identical mass m , one of which is at rest after the decay. Determine the mass m (relative to M) and the velocity of the moving particle after the decay. **(4 points)**

FORMULA SHEET

$$p \approx mv \quad (\text{if } v \ll c) \quad v = dx/dt \quad a = dv/dt \quad J = \Delta p$$

$$F = dp/dt$$

$$|F| = C v^2, \quad |F| = \mu N, \quad |F| = mg, \quad |F| = kx \quad F_x = -dU/dx$$

$$E = mgh \quad E = \frac{1}{2} mv^2 \quad E = \frac{1}{2} k (\Delta s)^2 \quad \Delta W = \vec{F} \cdot \Delta \vec{r}$$

$$\gamma = (1 - v^2/c^2)^{-1/2} \quad v\gamma = c(\gamma^2 - 1)^{1/2}$$

$$x' = \gamma(x - vt) \quad u' = (u - v)/(1 - uv/c^2)$$
$$t' = \gamma(t - (v/c^2)x)$$

$$\vec{p} = \gamma m \vec{v} \quad E = \gamma mc^2 \quad v/c^2 = p/E \quad E^2 = p^2 c^2 + m^2 c^4$$

$$1 \text{ light year} = c \times 1 \text{ year}$$
$$c \approx 3 \times 10^8 \text{ m/s}$$