

- 1 If the speed of an automobile increases by a factor of two, the distance that it takes to stop should increase by a factor of
 - a. 2.
 - b. 4.
 - c. 9.
 - d. 16.
 - e. 3.

- 2 An electrical power plant
 - a. destroys energy.
 - b. creates energy.
 - c. converts energy.

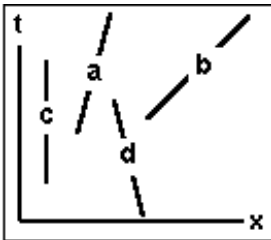
- 3 An automobile bumper jack moves the bumper up a distance of 0.01m (one centimeter) for every meter that the jack handle is moved downward. It is found that a force of 133N on the jack handle produces a lifting force of 10,000N on the bumper. What is the efficiency of this jack?
 - a. 66%.
 - b. 75%.
 - c. 100%.
 - d. 50%.

- 4 In a spacetime diagram with t the time and x the distance, all of the points on the space axis have
 - a. $x = 0$.
 - b. $t = x = 0$.
 - c. $t = x$.
 - d. $t = 0$.

- 5 The Michelson-Morely Experiment tested the predictions of
 - a. Newton's theory of mechanics.
 - b. the Aether theory of light propagation.
 - c. Einstein's theory of relativity.
 - d. Maxwell's theory of electromagnetism.

- 6 In comparison to Kepler's Laws of Planetary Motion, Newton's theory of Universal Gravitation predicted
 - a. almost the same motions but with corrections.
 - b. the same motions interpreted differently.
 - c. a completely different set of motions.
 - d. exactly the same motions.

- 7 A pendulum consists of a lead ball attached to one end of a string that is 1.25m long. The other end of the string is attached to a hook fixed in the ceiling. The pendulum is started by lifting the ball until the string is horizontal and the ball is against the ceiling. Which of the following answers is closest to the speed of the ball when it gets to the low point of its swing?
- 6m/s.
 - 8m/s.
 - 3.5m/s.
 - 25m/s.
 - 5m/s.
- 8 The first demonstration of electromagnetic wave generation used
- vacuum tube oscillators.
 - electric sparks in air.
 - rapid mechanical switches.
 - charged mechanical rotors.
- 9 Newton's theory of universal gravitation provided
- the first description of how objects move in the heavens.
 - the first unified description of both the motion of objects on earth and in the heavens.
 - the first description of how objects fall on the earth.
 - the first unified description of the fundamental forces of nature.
- 10 The space between the stars is not quite empty. It contains faint traces of gas as well as charged particles. If this interstellar medium were removed, the light from the stars
- would no longer reach us.
 - would still reach us.
 - would reach us only from stars emitting stellar winds.
- 11 The following spacetime diagram uses $c=1$ units. Which is the world-line of an object at rest?

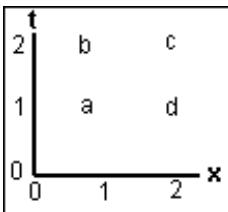


- 12 According to Einstein's procedure for assigning times to distant events, if you send out a radio wave pulse at 6:00p.m. and receive an echo back at 7:00p.m., then the pulse actually hit something at
- 6:00p.m.
 - 6:30p.m.
 - 7:00p.m.
 - a time that depends on your velocity.
 - a time that depends on the target's velocity.

- 13 A rogue star is observed to be headed directly for our sun. The expected collision will cause a supernova explosion with an initial flare of electromagnetic radiation capable of destroying everything in its path. Before the collision occurs, you get into a spaceship and speed away at 185,000 miles per second (relative to the sun). As you race away from the sun, the predicted supernova explosion occurs and sends its initial flare after you at 186,000 miles per second (relative to the former sun). As each second passes inside the ship, the distance between you and the flare closes (relative to the ship) by
- 186,000 miles.
 - 2000 miles.
 - 1000 miles.
 - 187,000 miles.
 - 185,000 miles.
- 14 In one experiment, two spheres, one with a mass of 1kg and the other with a mass of 1000kg are separated by one meter and attract each other with a tiny force. If the spheres are then replaced by one with a mass of 3kg and one with a mass of 2000kg, still one meter apart, the force between the masses will be
- three times the force in the first experiment.
 - the same as in the first experiment.
 - six times the force in the first experiment.
 - twice the force in the first experiment.
- 15 If the earth were compressed to the size of the moon — a factor of four in radius — with no change in its mass, the weight of a 100kg object on its surface would then be
- 4000N.
 - 250N.
 - 1000N.
 - 16000N.
 - 125N.
- 16 Lorentz sought to explain the result of the Michelson-Morely experiment by asserting that the aether-wind causes changes in
- time intervals.
 - the properties of light.
 - physical laws.
 - lengths.
- 17 Maxwell's derivation of the speed of light from physical laws was a problem for his fellow scientists because
- It violated energy conservation.
 - They disbelieved some steps in the derivation.
 - The speed was not what they expected.
 - It violated velocity addition.

- 18 Suppose that observers on Earth find that an asteroid collides with the planet Mars at exactly the same time that a comet collides with the earth. If a spaceship flying from Earth toward Mars observes these catastrophes, it will calculate that
- both happen at the same time.
 - Earth get hit before Mars does.
 - Mars get hit before the earth does.
- 19 The force on a 5kg object in a gravitational field whose magnitude is 4m/s^2 is equal to
- 4N.
 - 20N.
 - 50N.
 - 5N.
 - 6N.
- 20 A 2kg rock is dropped from rest at a height of 30 meters above the ground. How much heat energy is generated when it hits the ground?
- 600J.
 - 900J.
 - 0.
 - 60J.
- 21 Two spaceships travel, side-by-side, at nearly the speed of light (relative to the earth). Each ship sees the other just 0.1 light-years away in a direction perpendicular to their direction of motion. Each ship leaves a thin trail of gas as it travels. In a frame of reference at rest relative to the earth, the distance between the two gas trails will be
- 0.1 light years.
 - less than 0.1 light years.
 - more than 0.1 light years.
- 22 An aircraft carrier uses a catapult to launch airplanes from its deck. The catapult consists of a hook that runs along a slot in the deck. The airplane is attached to the hook and is pulled along the slot until it reaches take-off speed. Suppose that the catapult accelerates the plane at 5 times the acceleration of gravity (5 "g" 's) and the take-off speed is 100m/s. How long must the slot in the deck be?
- 100m.
 - 1000m.
 - 1m.
 - 10m.
 - 200m.

- 23 A spaceship travels from the earth to a star that is 12 light years away. If the trip takes 13 years in earth time, how many years pass on board the ship?
- 6.
 - 3.
 - 2.
 - 5.
 - 4.
- 24 Suppose that two objects, each with the same mass, are accelerated from rest to the same velocity. The force that accelerates one object is much larger than the force that accelerates the other object but acts for a shorter time. The work done by the larger force is
- equal to the work done by the smaller force.
 - smaller than the work done by the smaller force.
 - larger than the work done by the smaller force.
 - unrelated to the work done by the smaller force.
- 25 Suppose that a car and a truck are traveling at the same speed. If the truck has three times the mass of the car, then the truck's kinetic energy is
- nine times that of the car.
 - eight times that of the car.
 - four times that of the car.
 - twice that of the car.
 - three times that of the car.
- 26 In the following spacetime diagram, which letter is closest to the event with $x = 2$, $t = 1$?



- 27 Two spaceships fly side by side at nearly the speed of light, separated by a distance of 186,000 miles (one light-second in other words) in their own reference frame. If radio messages are exchanged between the ships the clocks on board the ships will find that each exchange is delayed by a round-trip travel time of
- more than 2s.
 - 2s.
 - less than 2s.
 - an indeterminate amount of time.

28 Which of the following phenomena consist of electromagnetic waves travelling at the speed of light?

- a. gamma radiation
- b. beta rays.
- c. alpha rays.
- d. gravity waves.

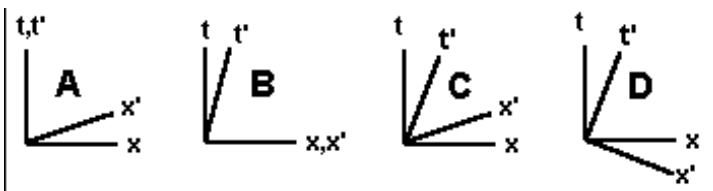
29 In the aether theory of light, a pulse of light travels at 186,000 miles per second relative to

- a. the aether.
- b. any inertial reference frame.
- c. the source of the light.
- d. the observer of the light.

30 The starship Enterprise is travelling on impulse drive at $4/5$ light speed. For every two minutes that pass on board the ship, a clock back on earth will read an interval close to

- a. two minutes.
- b. three minutes and twenty seconds.
- c. two minutes and ten seconds.
- d. two minutes and thirty seconds.

31 If Einstein were to draw a spacetime diagram in which the x' and t' axes represent a moving inertial frame, which of the following diagrams would he draw?



32 A complicated system of pulleys and gears is set up so that pulling down on an “input” rope by one meter causes an “output” rope to move upward by $1/5$ meter. If a force of 10 newtons is applied to the input rope, how much force can the output rope exert?

- a. 2N.
- b. 10N.
- c. 5N.
- d. 50N.

Answer Key: Fall 2007 PHX3A

- 1 Choice b. (4.)
- 2 Choice c. (converts energy.)
- 3 Choice b. (75%.)
- 4 Choice d. ($t = 0$.)
- 5 Choice b. (the Aether theory of light propagation.)
- 6 Choice a. (almost the same motions but with corrections.)
- 7 Choice e. (5m/s.)
- 8 Choice b. (electric sparks in air.)
- 9 Choice b. (the first unified description of both the motion of objects on earth and in the heavens.)
- 10 Choice b. (would still reach us.)
- 11 Choice c. (C)
- 12 Choice b. (6:30p.m.)
- 13 Choice a. (186,000 miles.)
- 14 Choice c. (six times the force in the first experiment.)
- 15 Choice d. (16000N.)
- 16 Choice d. (lengths.)
- 17 Choice d. (It violated velocity addition.)
- 18 Choice c. (Mars get hit before the earth does.)
- 19 Choice b. (20N.)
- 20 Choice a. (600J.)
- 21 Choice a. (0.1 light years.)
- 22 Choice a. (100m.)
- 23 Choice d. (5.)
- 24 Choice a. (equal to the work done by the smaller force.)
- 25 Choice e. (three times that of the car.)
- 26 Choice d. (D)
- 27 Choice b. (2s.)
- 28 Choice a. (gamma radiation)
- 29 Choice a. (the aether.)
- 30 Choice b. (three minutes and twenty seconds.)
- 31 Choice c. (C)
- 32 Choice d. (50N.)

Solutions

1. Module 021 Kinetic Energy: Question 4.2
2. Module 022 Total Energy: Question 3.2
3. Module 022 Total Energy: Question 5.1
4. Module r38 Maps of Spacetime: Question 1.2
5. Module r36 Michelson-Morely Experiment: Question 1.1
6. Module g31 Newton's Law of Universal Gravitation: Question 4.1
7. Module 022 Total Energy: Question 1.6
8. Module r34 Electromagnetic Waves: Question 2.1
9. Module g31 Newton's Law of Universal Gravitation: Question 3.2
10. Module r34 Electromagnetic Waves: Question 3.2
11. Module r38 Maps of Spacetime: Question 3.3b
12. Module r39 Map of a Moving Reference Frame: Question 2.2
13. Module r34 Electromagnetic Waves: Question 1.2
14. Module g31 Newton's Law of Universal Gravitation: Question 1.1
15. Module g31 Newton's Law of Universal Gravitation: Question 2.3
16. Module r36 Michelson-Morely Experiment: Question 2.1
17. Module r35 A Problem with Relativity: Question 1.1
18. Module r39 Map of a Moving Reference Frame: Question 4.1
19. Module g33 The Gravitational Field: Question 1.3
20. Module 022 Total Energy: Question 2.1
21. Module r40 Moving Clocks: Question 1.2
22. Module 021 Kinetic Energy: Question 5.4
23. Module r40 Moving Clocks: Question 4.4
24. Module 021 Kinetic Energy: Question 1.3
25. Module 021 Kinetic Energy: Question 2.2
26. Module r38 Maps of Spacetime: Question 2.2c
27. Module r40 Moving Clocks: Question 2.2
28. Module r34 Electromagnetic Waves: Question 4.2
29. Module r35 A Problem with Relativity: Question 2.1
30. Module r40 Moving Clocks: Question 3.3
31. Module r39 Map of a Moving Reference Frame: Question 3.1a Answer = C
32. Module 022 Total Energy: Question 4.2