

- 1 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.

- 2 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
 - a. less than 2s.
 - b. 2s.
 - c. more than 2s.
 - d. an indeterminate amount of time.

- 3 The force on a 5kg object in a gravitational field whose magnitude is 4m/s^2 is equal to
 - a. 20N.
 - b. 4N.
 - c. 50N.
 - d. 5N.
 - e. 6N.

- 4 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?
 - a. 1000m.
 - b. 200m.
 - c. 1m.
 - d. 10m.
 - e. 100m.

- 5 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?
 - a. 600J.
 - b. 900J.
 - c. 0.
 - d. 60J.

6 The Michelson-Morely Experiment tested the predictions of

- a. Newton's theory of mechanics.
- b. Maxwell's theory of electromagnetism.
- c. Einstein's theory of relativity.
- d. the Aether theory of light propagation.

7 An electrical power plant

- a. converts energy.
- b. creates energy.
- c. destroys energy.

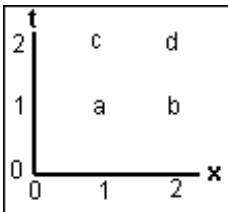
8 A pendulum consists of a lead ball attached to one end of a string that is 1.25m long. The other end of the string is attached to a hook fixed in the ceiling. The pendulum is started by lifting the ball until the string is horizontal and the ball is against the ceiling. Which of the following answers is closest to the speed of the ball when it gets to the low point of its swing?

- a. 5m/s.
- b. 8m/s.
- c. 25m/s.
- d. 6m/s.
- e. 3.5m/s.

9 In comparison to Kepler's Laws of Planetary Motion, Newton's theory of Universal Gravitation predicted

- a. exactly the same motions.
- b. almost the same motions but with corrections.
- c. a completely different set of motions.
- d. the same motions interpreted differently.

10 In the following spacetime diagram, which letter is closest to the event with $x = 2$, $t = 1$?

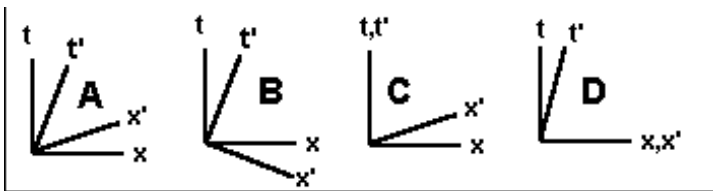


11 The first demonstration of electromagnetic wave generation used

- a. electric sparks in air.
- b. rapid mechanical switches.
- c. vacuum tube oscillators.
- d. charged mechanical rotors.

- 12 Which of the following phenomena consist of electromagnetic waves travelling at the speed of light?
- gamma radiation
 - alpha rays.
 - gravity waves.
 - beta rays.
- 13 Lorentz sought to explain the result of the Michelson-Morely experiment by asserting that the aether-wind causes changes in
- lengths.
 - time intervals.
 - physical laws.
 - the properties of light.

- 14 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?



- 15 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.
- 16 Newton's theory of universal gravitation provided
- the first description of how objects move in the heavens.
 - the first description of how objects fall on the earth.
 - the first unified description of the fundamental forces of nature.
 - the first unified description of both the motion of objects on earth and in the heavens.
- 17 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
- eight times that of the car.
 - three times that of the car.
 - twice that of the car.
 - four times that of the car.
 - nine times that of the car.

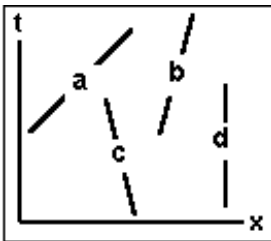
- 18 A rogue star is observed to be headed directly for our sun. The expected collision will cause a supernova explosion with an initial flare of electromagnetic radiation capable of destroying everything in its path. Before the collision occurs, you get into a spaceship and speed away at 185,000 miles 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.
 - 185,000 miles.
 - 1000 miles.
 - 187,000 miles.
 - 2000 miles.
- 19 Maxwell's derivation of the speed of light from physical laws was a problem for his fellow scientists because
- It violated velocity addition.
 - They disbelieved some steps in the derivation.
 - It violated energy conservation.
 - The speed was not what they expected.
- 20 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?
- 50%.
 - 66%.
 - 100%.
 - 75%.
- 21 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
- 4.
 - 3.
 - 2.
 - 16.
 - 9.
- 22 In the aether theory of light, a pulse of light travels at 186,000 miles per second relative to
- the aether.
 - any inertial reference frame.
 - the observer of the light.
 - the source of the light.

- 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?
- 4.
 - 3.
 - 2.
 - 6.
 - 5.
- 24 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
- Mars get hit before the earth does.
 - Earth get hit before Mars does.
 - both happen at the same time.
- 25 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
- the same as in the first experiment.
 - three times the force in the first experiment.
 - six times the force in the first experiment.
 - twice the force in the first experiment.
- 26 In a spacetime diagram with t the time and x the distance, all of the points on the space axis have
- $x = 0$.
 - $t = x$.
 - $t = x = 0$.
 - $t = 0$.
- 27 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
- smaller than the work done by the smaller force.
 - equal to 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.

28 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

- a. 1000N.
- b. 250N.
- c. 4000N.
- d. 16000N.
- e. 125N.

29 The following spacetime diagram uses $c=1$ units. Which is the world-line of an object at rest?



30 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

- a. 0.1 light years.
- b. less than 0.1 light years.
- c. more than 0.1 light years.

31 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. 50N.
- b. 5N.
- c. 2N.
- d. 10N.

32 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

- a. would no longer reach us.
- b. would still reach us.
- c. would reach us only from stars emitting stellar winds.

Answer Key: Fall 2007 PHX3D

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

Solutions

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