1 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. 0.

b. 60J.

c. 600J.

d. 900J.

2 The first direct confirmation of Maxwell's electromagnetic waves involved the generation and detection of

a. X-rays.

b. radio waves.

c. gamma rays.

d. light.

e. sound waves.

3 Which way does the earth's magnetic field point at a position directly over the magnetic south pole (somewhere in Antarctica).

a. north.

b. down.

c. south.

d. up.

4 If 100 coulombs of charge flows through a wire in 10 seconds, the current in the wire is

a. 10A.

b. 100A.

c. 0.1A.

d. 0.01A.

5 Which of the following answers is closest to the distance that an object will fall from rest in four seconds?

a. 20m.

b. 160m.

c. 320m.

d. 80m.

e. 40m.

6 An inertial reference frame is defined to be one in which

a. non-interacting objects have zero acceleration.

b. objects show resistance to acceleration.

c. the reference points are all moving at uniform velocity.

d. every force gives rise to an equal and opposite reaction force.

7 A pulley system lets you lift a 1000 newton weight a distance of 0.1 meter by pulling a rope a distance of one meter with a force of 150 newtons. The efficiency of this system is

a. 67%.

b. 80%.

c. 33%.

d. 50%.

e. 75%.

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

a. the source of the light.

b. the observer of the light.

c. any inertial reference frame.

d. the aether.

9 The Correspondence Principal guides

a. the testing of physical theories.

b. the application of mathematical methods to new physical systems.

c. the exchange of mail between scientists.

d. the replacement of an established physical theory by a new theory.

e. the transformation of one type of energy into another.

10 It is the year 2060 and you are participating in the 30th annual lunar skeet shoot. As a clay pigeon comes flying up from behind one of the moon's craters, you trigger your computerized magnetic rifle and let fly with an iron slug. Since there is no air on the moon, you can count on the uncomplicated laws of projectile motion that you learned in physics class. Your rifle is aimed by a computer that is designed to operate in open space where there is no gravity to contend with. Thus it aims at a point ahead of the pigeon where a straight-line path would predict it to be when the slug arrives. The computer does not take the moon's gravity into account and does not know that the pigeon is actually following a curved trajectory.

a. your slug always flies below the pigeon.

b. you hit the pigeon anyway.

c. your slug always flies above the pigeon.

11 If our sun were to be compressed to the size of the earth — a factor of 100 smaller in radius — the weight of a 100kg object on its surface would

a. increase by a factor of 100.

b. increase by a factor of 10,000.

c. decrease by a factor of 10,000.

d. decrease by a factor of 100.

12 A pair of electrically charged objects repel each other with a force of 144 Newton when they are a distance of 2m apart. If their charges stay the same, what will be the repulsive force between them when they are 8m apart?

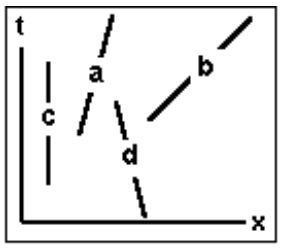
a. 9N.

b. 16N.

c. 144N.

d. 48N.

13 The following spacetime diagram uses c=1 units. Which is the world-line of an object moving in the positive-x direction at less than the speed of light?



14 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.

15 When you step on the gas in your car, the wheels push against the ground and the ground pushes back. The force that makes the car accelerate is exerted by

a. the ground.

b. the car engine.

c. the car wheels.

d. your foot.

16 Two identical clocks are set to the exact same time. One clock stays in the laboratory while the other clock is flown around the earth in a jet plane. When the clocks are brought back together, the flying clock reads

a. one tenth of a microsecond more time than the lab clock.

b. one tenth of a microsecond less time than the lab clock.

c. exactly the same time as the lab clock.

17 A rocket with a weight of $20,000$N is pointed straight up and fires its engines with a thrust of $200,000$N. The total force on this rocket is

a. $200,000$N upward.

b. $20,000$N downward.

c. $220,000$N upward.

d. $180,000$N downward.

e. $180,000$N upward.

18 Light that strikes a mirror at a 60 degree angle of incidence will reflect at an angle to the perpendicular of

a. 60 degrees.

b. 45 degrees.

c. 30 degrees.

d. 90 degrees.

19 The MKS unit of electrical resistance is the

a. volt.

b. ampere.

c. ohm.

d. watt.

e. coulomb.

20 You are in an elevator that is moving upward at a constant acceleration of 10m/s^2. The floor pushes up against your feet with a force

a. less than your weight.

b. equal to twice your weight.

c. of zero.

d. equal to your weight.

21 When the speed of an object is multiplied by 6, its kinetic energy

a. is multiplied by 9.

b. is multiplied by 36.

c. stays the same.

d. is multiplied by 6.

22 Which of the following types of image processing occurs in the retina of the eye?

a. compression.

b. angle recognition.

c. object recognition.

d. edge enhancement.

e. reconstruction.

23 (Astronomical note: In this part of the world, the sun rises in the east, moves across the southern sky, and sets in the west.) It has just stopped raining and you see a rainbow that is a full half-circle in the western sky. What time is it?

a. 6:00 am.

b. 6:00 pm.

c. 3:00 pm.

d. 9:00 am.

24 The photon theory predicts that the threshold frequency f_0 for the photoelectric effect

a. is a universal constant.

b. is usually zero.

c. depends on the light intensity.

d. depends on the work-function w.

25 Orbital velocity — 8000m/s — is a tiny fraction of the speed of light. In particular, it corresponds to $v/c = 2.67 \times 10^{-5}$. The quantity that occurs in the time dilation formula is even smaller, $(v/c)^2 = 7.13 \times 10^{-10}$. When highly accurate clocks are placed aboard earth satellites and compared to clocks on earth, the time dilation effect

a. has been observed but is too small to be of practical importance.

b. is large enough to sometimes be of practical importance.

c. is inherently unobservable.

d. is much too small to observe with current technology.

26 The eye stretches and relaxes its lens in order to

a. adapt to changing light intensity.

b. center the image on the fovea.

c. adapt its focus to objects at different distances.

d. keep the lens flexible.

e. express emotional interest.

27 In the eye, some of the convergence that brings rays to a focus is supplied by the

a. cornea.

b. pupil.

c. retina.

d. iris.

28 While flying along in their electric dirigible, Tom Swift and his friends notice a touring car roaring along the highway below them. Being full of boyish mischief (etc.), Tom and his friends decide to play a prank on the occupants of the car by dropping a bag of rubbish on them. The highway is long and straight, so it is easy to pilot the airship on a course parallel to the highway and directly over the moving car. Both the airship and the car are moving at forty miles per hour. Tom drops the bag when the car is directly underneath the airship and the speeds are matched. Assuming that the bag is heavy enough to be unaffected by air resistance,

a. the airship and the car leave the bag behind and it misses.

b. the bag hits the car.

c. The bag leaves the airship and car behind and lands ahead of the car.

29 Two twins in twin spaceships separate at 99% of the speed of light. When they separate, they are each 20 years old. They have agreed that one of them will turn around after one year of travel and fly back to rejoin the other. If the one who turns around is 22 years old when they get back together, the other twin will be

a. also 22 years old.

b. either older or younger than 22, there is no way to tell.

c. more than 22 years old.

d. less than 22 years old.

30 Newton's theory of universal gravitation provided

a. the first description of how objects move in the heavens.

b. the first description of how objects fall on the earth.

c. the first unified description of both the motion of objects on earth and in the heavens.

d. the first unified description of the fundamental forces of nature.

31 A converging lens

a. spreads parallel light rays apart.

b. spreads all light rays apart.

c. brings all light rays together.

d. brings parallel light rays together.

32 Galileo's approach to finding the laws that govern falling objects was to

a. test the predictions of the established theory.

b. prove the superiority of his own theory.

c. find logical contradictions in the established theory.

d. accept the established theory.

33 As the Earth moves around the Sun, the Earth's acceleration vector points

a. nowhere because it's zero.

b. towards the Sun.

c. away from the Sun.

d. in its direction of motion.

34 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

a. eight times that of the car.

b. twice that of the car.

c. four times that of the car.

d. nine times that of the car.

e. three times that of the car.

35 At the surface of the earth, a 2kg mass weighs approximately

a. 10 lb.

b. 2 N.

c. 20 N.

d. 5 N.

e. 30 N.

36 Suppose that a sound wave with a frequency of 1000Hz has a wavelength of one meter. Assuming that the speed of sound does not depend on frequency, the wavelength of a sound wave with a frequency of 250Hz should be

a. 1m.

b. 0.25m.

c. 16m.

d. 4m.

e. 0.0625m.

37 When all of the internal forces on an object (the forces that one part of the object exerts on another part) are added up, the total is always equal to

a. the last force added.

b. the average force times the square root of the number of parts.

c. the difference between odd and even numbered forces.

d. zero.

38 Optical illusions are primarily the result of the way images are

a. transmitted to the brain.

b. formed on the retina.

c. processed in the eye.

d. reconstructed by the brain.

39 Subway cars sometimes get their power from a "third rail" that is at a potential of about 600V above the potential of the other two rails (which are connected to the ground). If you are unfortunate enough to find yourself on the tracks of such a subway, which of the following situations is the most dangerous.

a. one foot on the third rail and one foot on another rail.

b. neither foot on a rail.

c. both feet on a grounded rail.

d. both feet on the third rail.

40 A spaceship is moving through the vacuum of space far from any planet or star when its engines fail. The spaceship will then

a. start to drift in unpredictable directions.

b. continue at the same speed in the same direction.

c. move in circles.

d. start moving backwards.

e. coast to a stop.

41 A fireworks shell takes five seconds to reach its maximum altitude. What was the vertical component of its initial velocity?

a. $5\,\mathrm{m/s}$.

b. $3000\,\mathrm{m/s}$.

c. $50\,\mathrm{m/s}$.

d. $30\,\mathrm{m/s}$.

e. $500\,\mathrm{m/s}$.

42 A ball is thrown straight up with an initial velocity of 5m/s. The ball is fairly heavy, so air resistance can be neglected. How long will it take to go up and fall back to the level at which it was thrown?

a. $1\,\mathrm{s}$.

b. $0.5\,\mathrm{s}$.

c. $5\,\mathrm{s}$.

d. $2\,\mathrm{s}$.

e. $10\,\mathrm{s}$.

43 In Newton's second law of motion, $F = ma$, which of the following quantities depends only on the moving object and not on the object's surroundings or the way that it is moving?

a. a.

b. a/m.

c. m/a.

d. F.

e. m.

44 You apply the brakes in your car and feel yourself thrown forward against your shoulder straps. The acceleration vector of your car points

a. backwards.

b. forwards.

c. sideways.

d. upwards.

45 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 4kg and one with a mass of 3000kg, still one meter apart, the force between the masses will be

a. twelve times the force in the first experiment.

b. the same as in the first experiment.

c. three times the force in the first experiment.

d. four times the force in the first experiment.

46 Devices that are described as "motors," or "engines"

a. destroy energy.

b. convert existing energy into mechanical energy.

c. create energy.

d. extract energy from the aether.

47 You are standing in a stream (up to your knees) and see a fish swimming by. If you wish to hit the fish with a spear, you should

a. aim directly at where you see it.

b. aim below where you see it.

c. aim above where you see it.

d. aim beside where you see it.

48 The potential energy of a charge of 3 micro-coulombs in a potential of 1 million volts is

a. 1J.

b. 2J.

c. 6J.

d. 3J.

49 Suppose that you slowly lower a pail to the ground from a height of 1.5meters above the ground. The pail weighs 100N. How much work is done by the force that you exert on the pail?

a. -150Nm.

b. 150Nm.

c. -100Nm.

d. 100Nm.

50 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?

a. 6.

b. 5.

c. 2.

d. 3.

e. 4.

51 The idea that light would be dragged by the aether wind caused by the earth's motion around the sun was tested by

a. Heinrich Hertz in 1888.

b. James Clerk Maxwell in 1865.

c. Einstein in 1905.

d. Michelson and Morely in 1887.

52 The speed of light is 3×10^8m/s. How much energy is released when the mass of a system decreases by one gram (10^{-3}kg)?.

a. 9×10^{13}J.

b. 3×10^5J.

c. 9×10^{10}J.

d. 9×10^{16}J.

53 A baseball pitcher acquires an unbalanced electrical charge by scuffing his feet in the dirt and transfers -0.00001C to a baseball as he throws it toward home plate. A thunderstorm is brewing and there is a vertical electric field of 10,000N/C *pointing straight up*. The electrical force on the baseball is

a. 1N downward.

b. 0.1N downward.

c. 1N upward.

d. 0.1N upward.

54 The set of wavelengths present in the light from a given source is that source's

a. intensity.
b. spectrum.
c. radiation curve.
d. electronic structure.

55 A total eclipse of the moon happens when

a. the moon passes into the penumbra of the earth's shadow.
b. the earth passes into the penumbra of the moon's shadow.
c. the earth passes into the umbra of the moon's shadow.
d. the moon passes into the umbra of the earth's shadow.

56 Near a positive charge, the electric field points

a. directly toward the charge.
b. in circles around the charge.
c. upward.
d. directly away from the charge.

57 Suppose that the nozzle of a fire hose emits a stream of water at a velocity of 30m/s and a rate of 10kg/s. Assuming that the water in the hose is moving at 10m/s, how much force does the nozzle exert on the fireman who is holding it?

a. 0 N.
b. 300 N.
c. 100 N.
d. 200 N.

58 Lasers can do things that were once thought to be impossible because laser light is very

a. coherent.
b. high velocity.
c. short wavelength.
d. long wavelength.
e. intense.

59 Several effects can limit the amount of unbalanced charge on an object. As the amount of unbalanced positive electric charge on a doorknob increases, which of the following limiting effects happens first?

a. Every atom in the doorknob has lost an electron.
b. Electrons pulled from surrounding atoms mob the doorknob.
c. Every atom on the surface of the doorknob has lost an electron.

60 Which of the following statements is scientific (as defined by Popper)?

a. There are fish in Lake Nyak.
b. All of the fish in Lake Nyak are beautiful.
c. All of the fish in Lake Nyak are green.

61 For an accelerated particle, proper time and rest-mass are defined

a. only in the universal inertial frame.

b. using gravity because of the acceleration.

c. in the inertial frame of the observer.

d. in the instantaneous rest-frame of the particle.

62 The light frequencies that a particular atom can emit are always

a. less than the frequencies that it can absorb.

b. independent of the frequencies that it can absorb.

c. greater than the frequencies that it can absorb.

d. the same as the frequencies that it can absorb.

63 A (hypothetical) atom has a ground state at -3eV, a first excited state at -2eV and a second excited state at -1eV. If a transition from the first excited state to the ground state yields a photon of frequency f, then a transition from the second excited state to the ground state must yield a photon of frequency

a. $\frac{1}{2}f$

b. $2f$

c. $3f$

d. f

64 The Lorentz contraction was originally proposed as an explanation for

a. The perihelion precession of Mercury.

b. the dragging of light by the aether.

c. the bending of light by the sun.

d. the null result of the Michelson Morely experiment.

65 The process of total internal reflection typically loses

a. none of the incident energy.

b. about 50% of the incident energy.

c. about 1% of the incident energy.

d. 96% of the incident energy.

66 A positive charge of one micro-coulomb is one meter away from a much larger positive charge and has one joule of potential energy. If the charge moves to one half meter away from the positive charge, its potential energy could be

a. 1J.

b. 2J.

c. 0.5J.

67 A cyclist travels 200 miles in 10 hours. His speed is

a. $1/20$hr/mi.

b. 20mi/hr.

c. $1/10$hr/mi.

d. 200mi/ hr.

e. 10mi/ hr.

68 The image that is seen in a mirror is

a. always a virtual image.

b. virtual only when light cannot get behind the mirror.

c. always a real image.

d. real only when light can get behind the mirror.

69 Newton's law of universal gravitation contains the constant G while Coulomb's law contains the constant k. Compare the values of these constants in MKS units.

a. k is much larger (by many factors of 10) than G.

b. $k = G$.

c. $k = 2\pi G$.

d. G is much larger (by many factors of 10) than k.

70 The prediction that light of any frequency can eject electrons from a metal is made by

a. neither the wave theory nor the particle theory.

b. both the wave theory and the particle theory.

c. the particle theory.

d. the wave theory.

71 The eye adapts to changing light intensity by

a. stretching and relaxing its lens.

b. opening and closing its pupil.

c. lengthening and shortening the eyeball.

d. modifying its cornea.

72 If a compass needle is brought near a magnet, it will point toward the magnet's

a. center.

b. north-seeking pole.

c. south-seeking pole.

d. bottom.

e. top.

73 Electromagnetic waves propagate

a. only where there are charged particles.

b. through anything at all.

c. through a vacuum.

d. only in air or water.

74 An anvil that weighs 300 pounds is dropped at the same time as a hammer that weighs 10 pounds. Assuming that both objects are dropped from the same height and air resistance can be neglected, which of the following statements would currently accepted ideas predict?

a. The hammer and anvil hit the ground almost together.

b. The anvil hits the ground long before the hammer.

c. The hammer hits the ground long before the anvil.

75 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. 3.5m/s.

b. 5m/s.

c. 8m/s.

d. 25m/s.

e. 6m/s.

76 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. 2s.

b. less than 2s.

c. more than 2s.

d. an indeterminate amount of time.

77 Suppose that the focal point of a converging lens is 4cm from the lens. If an object is placed 3.9cm from the lens, then its image will be

a. reduced and real.

b. enlarged and virtual.

c. reduced and virtual.

d. enlarged and real.

78 Suppose that it takes an average force of 2000 Newtons to draw a catapult back by two meters. How much potential energy is stored in the drawn catapult?

a. 0J.

b. 2000J.

c. 200J.

d. 400J.

e. 4000J.

79 Suppose that a baseball is thrown with a horizontal velocity component of 30 m/s (about 66 miles per hour which is not too difficult) and a vertical velocity component of 5m/s. How far will it travel before coming back down to the level at which it was thrown?

a. 10m.

b. 60m.

c. 80m.

d. 30m.

e. 20m.

80 The work required to accelerate an object from rest to a given velocity is called the object's

a. Kinetic Energy.

b. Potential Energy.

c. Mass Energy.

d. Total Energy.

e. Rest Energy.

81 A car drives off a cliff. As it leaves the cliff, its horizontal velocity component is 5m/s and its vertical velocity component is 0m/s. One second later, its horizontal velocity component is still 5m/s and its vertical velocity component is -10m/s. What is its *horizontal component* of acceleration?

a. $+10$m/s^2.

b. 0m/s^2.

c. $+5$m/s^2.

d. -10m/s^2.

82 If one of two charges is increased by a factor of 6 and the distance between the charges is not changed, then the electrical force between the charges is

a. unchanged.

b. multiplied by 6.

c. divided by 6.

d. divided by 36.

83 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

a. 187,000 miles.

b. 185,000 miles.

c. 2000 miles.

d. 186,000 miles.

e. 1000 miles.

84 Which of the following light sources emits a continuous spectrum?

a. a glowing coal.

b. a mercury-vapor lamp.

c. a neon light.

d. hot, thin interstellar gas.

85 When white light enters a prism, its different wavelengths are sent in different directions. When light goes out the other side of the prism, this separation of wavelengths

a. is increased.

b. is decreased but not canceled.

c. is completely canceled.

d. stays the same.

86 In which of the following situations would an automobile be in equilibrium?

a. Moving at constant speed in a circle.

b. Moving at constant speed over the top of a hill.

c. Accelerating away from a stop light.

d. Moving at constant speed down a long straight incline.

e. Accelerating down a long straight incline.

87 Suppose that you slowly lower a 10kg pail of water into a well from ground level to a distance of 1.5 meters below the ground. How much does the potential energy of the pail change?

a. increases by 150J.

b. increases by 100J.

c. decreases by 100J.

d. decreases by 150J.

88 When one coulomb of charge passes through a battery, the electrical potential energy of the charge increases by 1.5J. If 4 coulombs of charge pass through the same battery, its electrical potential energy will increase by

a. 6.0J.

b. 1.5J.

c. 3.0J.

d. 0.375J.

89 Suppose that the weight of a block is 100N. How much work does the force of gravity do on the block when the block moves a distance of 2 meters along a level surface?

a. 0J.

b. 10J.

c. 40J.

d. 200J.

90 A few millimeters per second is

a. the typical average speed of electrons in a current-carrying wire.

b. the instantaneous speed of individual electrons in a wire.

c. a speed that has nothing to do with electricity.

d. the typical speed with which a change in electric potential moves through a wire.

91 Suppose that a car that is moving North is said to have a velocity component of 50 miles per hour. For North-South distances measured in the same way, a car with a velocity component of -50 mph *must* then be moving

a. East.

b. West.

c. North.

d. South.

92 The frequency of a wave is

a. the reciprocal of its rate of spread.

b. the distance from one wavefront to the next.

c. the rate at which waves pass a fixed position.

d. the distance from its beginning to its end.

e. the velocity of a wavefront.

93 All of the following statements are true. Which one states the ray approximation?

a. Rays spread outward from a source.

b. Rays are perpendicular to wavefronts.

c. For short wavelengths, rays are straight lines.

d. For long wavelengths, rays bend around corners.

94 If a bar magnet is cut in half, the result will be

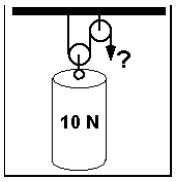
a. one half with a strong north-seeking pole and a weak south-seeking pole and one half the reverse.

b. one half that is a north-seeking pole and one half that is a south-seeking pole.

c. cancellation of the magnetic field.

d. two bar magnets, each with a north-seeking pole on one end and an equally strong south-seeking pole on the other.

95 A ten newton weight is hung from the ceiling with the pulley system shown here. The force that must be exerted on the end of the string to hold the weight in equilibrium is



a. 5 N.

b. 10 N.

c. 20 N.

d. $3\frac{1}{3}$ N.

96 A man is trying to push a railroad car along a level track. He is able to exert a horizontal force of about 1000N and the friction force is negligible. If the mass of the railroad car is 100 metric tons or $100,000$kg, it will accelerate along the track at

a. 0m/s^2.

b. 100m/s^2.

c. 0.01m/s^2.

d. 0.009m/s^2.

e. 90m/s^2.

97 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. $t = 0$.

d. $t = x$.

98 If an automobile moving at a speed of 20 miles per hour can stop in a distance of 50 feet, how much distance should it take for a car moving at 40 miles per hour to stop on the same surface?

a. 300ft.

b. 100ft.

c. 200ft.

d. 900ft.

e. 50ft.

99 At 2:00 P.M. a swimming pool contains 5500 gallons of water. At 5:00 P.M. it contains 4000 gallons of water. The *rate* of change in the amount of water in the pool is

a. +5500 gal/hr.

b. -1500 gal/hr.

c. - 500 gal/hr.

d. + 500 gal/hr.

e. +1500 gal/hr.

100 For light of intensity 10W/m^2, the threshold frequency for the photoelectric effect on a certain metal is 10^{15}Hz. For light of intensity 100W/m^2 on the same metal, the threshold will be

a. 10^{16}Hz

b. 10^{15}Hz

c. 10^{13}Hz

d. 10^{14}Hz

101 A voltage drop of 3V causes 5A of current to flow through a light bulb. Assuming that Ohm's Law applies here, what voltage drop would cause a current of 15A to flow through the bulb?

a. 25V.

b. 9V.

c. 5V.

d. 27V.

102 Suppose that you are pushing a large packing crate along a tile floor. You had to exert a force to start the box moving. Compared to this force, the force that you must exert to keep the box sliding along the floor is

a. the same.

b. larger.

c. smaller.

103 A near-sighted person, someone who has trouble focusing on distant objects, needs to wear glasses with

a. flat lenses.

b. diverging lenses.

c. barrel-shaped lenses.

d. converging lenses.

104 The MKS unit of force is the

a. kilogram.

b. m/s^2.

c. pound.

d. newton.

105 If light is incident on a diffuse reflector from a single direction, it will be

a. reflected without loss.

b. completely absorbed.

c. reflected into a single direction.

d. scattered in all directions.

106 Consider two stones, one with twice the mass of the other. If you throw each stone equally hard,

a. both stones will be accelerated to the same speed.

b. the more massive stone will accelerate more.

c. the less massive stone will accelerate more.

107 Of the following types of electromagnetic radiation, which has the second shortest wavelength?

a. red light.

b. infra-red light.

c. FM radio waves.

d. microwaves.

108 Calculate (based on the assumptions made in class) the smallest potential difference that could possibly cause death to someone touching bare terminals with clean hands.

a. 50V.

b. 5V.

c. 120V.

d. 5000V.

e. 24V.

109 A ship with a mass of $100,000\,\mathrm{kg}$ is traveling at $3\,\mathrm{m/s}$ when it hits a smaller ship of mass $50,000\,\mathrm{kg}$ that is at rest. The total momentum of these two ships is

a. $+100,000\,\mathrm{kg\,m/s}$.

b. $-150,000\,\mathrm{kg\,m/s}$.

c. $+3.0\,\mathrm{kg\,m/s}$.

d. $+300,000\,\mathrm{kg\,m/s}$.

e. $+150,000\,\mathrm{kg\ m/s}$.

110 A laser requires a large number of electrons to be in identical excited states that are

a. very good at absorbing photons.

b. very good at emitting photons.

c. incapable of emitting photons.

d. very poor at emitting photons.

111 The Principle of Relativity is primarily due to

a. Einstein.

b. Maxwell.

c. Galileo.

d. Aristotle.

112 The rate of change of an object's velocity vector is called its

a. power level.

b. rotation rate.

c. deceleration.

d. acceleration.

113 At 4:00 P.M. an airplane is in the final leg of its landing approach, with the distance between it and the ground changing at the rate of -5.0 meters per second. At 4:01 P.M., it touches the ground and begins to roll down the runway without so much as a single bounce. What is the instantaneous rate of change of the distance between the plane and the ground at one second after 4:01 P.M.?

a. -5.0 m/s.

b. +4.0 m/s.

c. 0.0 m/s.

d. -4.0 m/s.

e. +5 m/s.

114 A clock comparison is initiated by a spaceship, which sends out the message *"This is freighter MS701. Please send GMT time-check."*. According to the ship's clock, the message is sent at 5:00 P.M. At 6:00 P.M. by its clock, the ship receives the message *"Read you, MS701. Phobos station time is now 5:20 P.M. GMT"*. Freighter MS701 needs to reset its clock. Assuming that Phobos Station responded immediately (as it was programmed to do), the ship should change its clock reading from 6:00 P.M. to

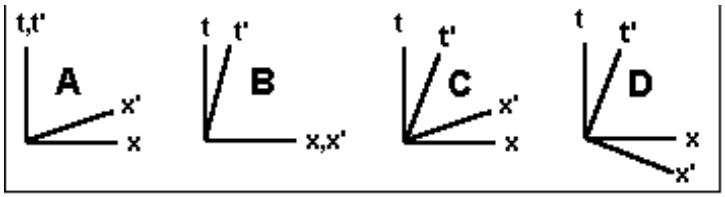
a. 5:50 P.M.

b. 5:30 P.M.

c. 5:20 P.M.

d. 6:10 P.M.

115 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?



116 If a particle whose rest-mass-energy is 1 Mev travels at 4/5 the speed of light, its kinetic energy is

a. $(2/3)$Mev.

b. $(8/5)$Mev.

c. $(1/4)$Mev.

d. $(1/12)$Mev.

117 In the MKS system of units, the volt is defined by

a. 1V = 1N/C.

b. 1V = 1C/N.

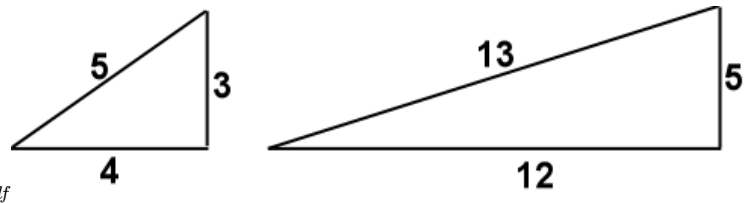
c. 1V = 1J/C.

d. 1V = 1C/J.

Useful Formulas

$p = mv$	$W = F_d d = F d_F$	$F = ma$
$\text{K.E.}_{\text{Newton}} = \frac{1}{2}mv^2$	$\text{P.E.} = mgh$	$W = mg$
$v = at$	$v^2 = 2ad$	$d = \frac{1}{2}at^2$
$v_{\text{average}} = \frac{d}{t}$	$\text{Eff} = \frac{\text{Work out}}{\text{Work in}}$	$P = \frac{\text{Work done}}{\text{Time taken}}$
$F = G\frac{mM}{D^2}$	$t_{\text{earth}} = \frac{T_{\text{ship}}}{\sqrt{1-v^2}}$	$E = \frac{mc^2}{\sqrt{1-(v/c)^2}}$
$F = k\frac{qQ}{D^2}$	$\text{K.E.}_{\text{Einstein}} = E - mc^2$	${T_{\text{ship}}}^2 = {t_{\text{earth}}}^2 - {x_{\text{earth}}}^2$
$E = \frac{\text{Force}}{\text{Electric charge}}$	$V = \frac{\text{P.E.}_{\text{electrical}}}{\text{Electric charge}}$	$I = \frac{\text{Charge flow}}{\text{Time taken}}$
$P = IV$	$R = \frac{V}{I}$	$v = f\lambda$
$E_{\text{photon}} = hf$	$hf = \text{K.E.}_{\text{electron}} + w$	$hf_{1\to 2} = E_1 - E_2$

Integer right triangles:
triangles



$_4.pdf$

Answer Key: Practice Final Exam 2

1 Choice c. (600J.)

2 Choice b. (radio waves.)

3 Choice d. (up.)

4 Choice a. (10A.)

5 Choice d. (80m.)

6 Choice a. (non-interacting objects have zero acceleration.)

7 Choice a. (67%.)

8 Choice d. (the aether.)

9 Choice d. (the replacement of an established physical theory by a new theory.)

10 Choice b. (you hit the pigeon anyway.)

11 Choice b. (increase by a factor of 10,000.)

12 Choice a. (9N.)

13 Choice a. (A)

14 Choice a. (almost the same motions but with corrections.)

15 Choice a. (the ground.)

16 Choice b. (one tenth of a microsecond less time than the lab clock.)

17 Choice e. ($180,000$N upward.)

18 Choice a. (60 degrees.)

19 Choice c. (ohm.)

20 Choice b. (equal to twice your weight.)

21 Choice b. (is multiplied by 36.)

22 Choice d. (edge enhancement.)

23 Choice a. (6:00 am.)

24 Choice d. (depends on the work-function w.)

25 Choice b. (is large enough to sometimes be of practical importance.)

26 Choice c. (adapt its focus to objects at different distances.)

27 Choice a. (cornea.)

28 Choice b. (the bag hits the car.)

29 Choice c. (more than 22 years old.)

30 Choice c. (the first unified description of both the motion of objects on earth and in the heavens.)

31 Choice d. (brings parallel light rays together.)

32 Choice a. (test the predictions of the established theory.)

33 Choice b. (towards the Sun.)

34 Choice e. (three times that of the car.)

35 Choice c. ($20\,\mathrm{N}$.)

36 Choice d. (4m.)

37 Choice d. (zero.)

38 Choice d. (reconstructed by the brain.)

39 Choice a. (one foot on the third rail and one foot on another rail.)

40 Choice b. (continue at the same speed in the same direction.)

41 Choice c. ($50\,\mathrm{m/s}$.)

42 Choice a. ($1\,\mathrm{s}$.)

43 Choice e. (m.)

44 Choice a. (backwards.)

45 Choice a. (twelve times the force in the first experiment.)

46 Choice b. (convert existing energy into mechanical energy.)

47 Choice b. (aim below where you see it.)

48 Choice d. (3J.)

49 Choice a. (-150Nm.)

50 Choice b. (5.)

51 Choice d. (Michelson and Morely in 1887.)

52 Choice a. (9×10^{13}J.)

53 Choice b. (0.1N downward.)

54 Choice b. (spectrum.)

55 Choice d. (the moon passes into the umbra of the earth's shadow.)

56 Choice d. (directly away from the charge.)

57 Choice d. ($200\,\mathrm{N}$.)

58 Choice a. (coherent.)

59 Choice b. (Electrons pulled from surrounding atoms mob the doorknob.)

60 Choice c. (All of the fish in Lake Nyak are green.)

61 Choice d. (in the instantaneous rest-frame of the particle.)

62 Choice d. (the same as the frequencies that it can absorb.)

63 Choice b. ($2f$)

64 Choice d. (the null result of the Michelson Morely experiment.)

65 Choice a. (none of the incident energy.)

66 Choice b. (2J.)

67 Choice b. (20mi/hr.)

68 Choice a. (always a virtual image.)

69 Choice a. (k is much larger (by many factors of 10) than G.)

70 Choice d. (the wave theory.)

71 Choice b. (opening and closing its pupil.)

72 Choice c. (south-seeking pole.)

73 Choice c. (through a vacuum.)

74 Choice a. (The hammer and anvil hit the ground almost together.)

75 Choice b. (5m/s.)

76 Choice a. (2s.)

77 Choice b. (enlarged and virtual.)

78 Choice e. (4000J.)

79 Choice d. (30m.)

80 Choice a. (Kinetic Energy.)

81 Choice b. (0m/s^2.)

82 Choice b. (multiplied by 6.)

83 Choice d. (186,000 miles.)

84 Choice a. (a glowing coal.)

85 Choice a. (is increased.)

86 Choice d. (Moving at constant speed down a long straight incline.)

87 Choice d. (decreases by 150J.)

88 Choice a. (6.0J.)

89 Choice a. (0J.)

90 Choice a. (the typical average speed of electrons in a current-carrying wire.)

91 Choice d. (South.)

92 Choice c. (the rate at which waves pass a fixed position.)

93 Choice c. (For short wavelengths, rays are straight lines.)

94 Choice d. (two bar magnets, each with a north-seeking pole on one end and an equally strong south-seeking pole on the other.)

95 Choice a. (5 N.)

96 Choice c. (0.01m/s^2.)

97 Choice c. ($t = 0$.)

98 Choice c. (200ft.)

99 Choice c. (- 500 gal/hr.)

100 Choice b. (10^{15}Hz)

101 Choice b. (9V.)

102 Choice c. (smaller.)

103 Choice b. (diverging lenses.)

104 Choice d. (newton.)

105 Choice d. (scattered in all directions.)

106 Choice c. (the less massive stone will accelerate more.)

107 Choice b. (infra-red light.)

108 Choice a. (50V.)

109 Choice d. ($+300,000\,\mathrm{kg\,m/s}$.)

110 Choice d. (very poor at emitting photons.)

111 Choice c. (Galileo.)

112 Choice d. (acceleration.)

113 Choice c. (0.0 m/s.)

114 Choice a. (5:50 P.M.)

115 Choice c. (C)

116 Choice a. ((2/3)Mev.)

117 Choice c. (1V = 1J/C.)

Where to find things in the notes

1 Module 022 Total Energy: Question 2.1
2 Module r34 Electromagnetic Waves: Question 2.2
3 Module 092 Magnetic Poles: Question 4.2
4 Module 084 Electric Current: Question 1.2
5 Module 021 Kinetic Energy: Question 5.2
6 Module 014 The Law of Inertia: Question 2.2
7 Module 022 Total Energy: Question 5.2
8 Module r35 A Problem with Relativity: Question 2.1
9 Module r42 Relativistic Mechanics: Question 1.2
10 Module 013 Projectile Motion: Question 2.1
11 Module g31 Newton's Law of Universal Gravitation: Question 2.1
12 Module 077 Coulomb's Force Law: Question 1.4
13 Module r38 Maps of Spacetime: Question 3.1b
14 Module g31 Newton's Law of Universal Gravitation: Question 4.1
15 Module 018 Action and Reaction: Question 2.1
16 Module r41 The Twin Paradox: Question 1.2
17 Module 016 The Law of Force and Mass: Question 3.2
18 Module 102 Interactions at boundaries: Question 1.2
19 Module 086 Electrical Resistance: Question 1.2
20 Module 017 Some Forces: Question 3.2
21 Module 021 Kinetic Energy: Question 3.1
22 Module 110 Image Processing: Question 1.2
23 Module 103 Dispersion effects: Question 3.1
24 Module 117 The Photoelectric Effect: Question 3.1
25 Module r41 The Twin Paradox: Question 4.2
26 Module 109 Anatomy: Question 3.2
27 Module 109 Anatomy: Question 1.2
28 Module 013 Projectile Motion: Question 1.3
29 Module r41 The Twin Paradox: Question 3.2
30 Module g31 Newton's Law of Universal Gravitation: Question 3.2
31 Module 106 Lenses: Question 1.3
32 Module 010 Universality of Free-fall: Question 3.1
33 Module 009 Acceleration and Speed: Circular Motion: Question 4N
34 Module 021 Kinetic Energy: Question 2.2
35 Module 017 Some Forces: Question 1.2
36 Module 099 Wave Properties: Question 4.3

37 Module 018 Action and Reaction: Question 1.1
38 Module 110 Image Processing: Question 3.1
39 Module 083 Definition of Electric Potential: Question 4.1
40 Module 005 The law of inertia.: Question 3N
41 Module 012 Constant Acceleration: Question 2.2
42 Module 012 Constant Acceleration: Question 4.3
43 Module 015 Mass, Measure of Inertia: Question 2.3
44 Module 009 Acceleration and Speed: Linear Motion: Question 3A
45 Module g31 Newton's Law of Universal Gravitation: Question 1.3
46 Module 022 Total Energy: Question 3.1
47 Module 102 Interactions at boundaries: Question 3.1
48 Module 083 Definition of Electric Potential: Question 2.2
49 Module 019 Work: Question 3.1
50 Module r40 Moving Clocks: Question 4.4
51 Module r36 Michelson-Morely Experiment: Question 1.2
52 Module r42 Relativistic Mechanics: Question 4.1
53 Module 080 Definition of an Electric Field: Question3.2
54 Module 100 The Electromagnetic Spectrum: Question 4.2
55 Module 104 The Ray Approximation: Question 3.2
56 Module 080 Definition of an Electric Field: Question 1.1
57 Module 018 Action and Reaction: Question 4.1
58 Module 119 Lasers: Question 4.1
59 Module 077 Coulomb's Force Law: Question 4.3
60 Module 001 How to test a statement : Question 2.3
61 Module r42 Relativistic Mechanics: Question 2.1
62 Module 118 Atomic Spectra: Question 3.2
63 Module 118 Atomic Spectra: Question 2.1
64 Module r36 Michelson-Morely Experiment: Question 2.2
65 Module 102 Interactions at boundaries: Question 4.2
66 Module 082 Electric Potential Energy: Question 1.1
67 Module 008 Speed: Question 3.3
68 Module 105 Images: Question 3.2
69 Module 077 Coulomb's Force Law: Question 3.2
70 Module 117 The Photoelectric Effect: Question 1.2
71 Module 109 Anatomy: Question 4.1
72 Module 092 Magnetic Poles: Question 1.2
73 Module r34 Electromagnetic Waves: Question 3.1

74 Module 010 Universality of Free-fall: Question 2.2
75 Module 022 Total Energy: Question 1.6
76 Module r40 Moving Clocks: Question 2.2
77 Module 107 Optical Instruments: Question 2.3
78 Module 020 Potential Energy: Question 4.3
79 Module 013 Projectile Motion: Question 4.3
80 Module 021 Kinetic Energy: Question 1.2
81 Module 009 Components of Acceleration: Question 1A
82 Module 077 Coulomb's Force Law: Question 2.2
83 Module r34 Electromagnetic Waves: Question 1.2
84 Module 118 Atomic Spectra: Question 4.1
85 Module 103 Dispersion effects: Question 1.3
86 Module 016 The Law of Force and Mass: Question 4.3
87 Module 020 Potential Energy: Question 3.1
88 Module 082 Electric Potential Energy: Question 4.1
89 Module 019 Work: Question 4.3
90 Module 084 Electric Current: Question 3.2
91 Module 008 Components of Velocity: Question 1.4
92 Module 099 Wave Properties: Question 3.2
93 Module 104 The Ray Approximation: Question 2.1
94 Module 092 Magnetic Poles: Question 3.2
95 Module 018 Action and Reaction: Question 3.1
96 Module 016 The Law of Force and Mass: Question 2.3
97 Module r38 Maps of Spacetime: Question 1.2
98 Module 021 Kinetic Energy: Question 4.4
99 Module 007 Negative Rate of Change Question 4.5
100 Module 117 The Photoelectric Effect: Question 4.3
101 Module 086 Electrical Resistance: Question 2.1
102 Module 017 Some Forces: Question 2.2
103 Module 107 Optical Instruments: Question 3.3
104 Module 016 The Law of Force and Mass: Question 1.1
105 Module 102 Interactions at boundaries: Question 2.2
106 Module 015 Mass, Measure of Inertia: Question 1.1
107 Module 100 The Electromagnetic Spectrum: Question 2.1
108 Module 086 Electrical Resistance: Question 4.2
109 Module 018 Action and Reaction: Question 5.6
110 Module 119 Lasers: Question 2.1

111 Module 014 The Law of Inertia: Question 3.1

112 Module 009 The Acceleration Vector: Question 2.4

113 Module 007 Instantaneous Rate of Change: Question 5A

114 Module r39 Map of a Moving Reference Frame: Question 2.1

115 Module r39 Map of a Moving Reference Frame: Question 3.1a Answer = C

116 Module r42 Relativistic Mechanics: Question 3.2

117 Module 083 Definition of Electric Potential: Question 1.1