SINGAPORE JUNIOR PHYSICS OLYMPIAD 2013
GENERAL ROUND

31 August, 2013

3:00 pm – 4:30 pm

Time Allowed: ONE hour THIRTY minutes

INSTRUCTIONS

1. This paper contains **50** multiple choice questions and **19** printed pages.
2. Each of the questions or incomplete statements is followed by five suggested answers or completions. Select the one that is best in each case and then shade the corresponding bubble on the answer sheet.
3. Only the answer sheet will be collected at the end of the test. Answers written anywhere else will not be marked.
4. Use 2B pencil only. Using any other type of pencil or pen may result in answers unrecognizable by the machine.
5. Answer all questions. Marks will **NOT** be deducted for wrong answers.
6. Scientific calculators are allowed in this test. Graphic calculators are not allowed.
7. A table of information is given in page 2.

TABLE OF INFORMATION

Acceleration due to gravity at Earth surface, g	=	$9.80\ \text{m/s}^2$
Universal gas constant, R	=	$8.31\ \text{J/(mol} \cdot \text{K)}$
Vacuum permittivity, ϵ_0	=	$8.85 \times 10^{-12}\ \text{C}^2/(\text{N} \cdot \text{m}^2)$
Vacuum permeability, μ_0	=	$4\pi \times 10^{-7}\ \text{T} \cdot \text{m/A}$
Atomic mass unit, u	=	$1.66 \times 10^{-27}\ \text{kg}$
Speed of light in vacuum, c	=	$3.00 \times 10^{8}\ \text{m/s}$
Charge of electron, e	=	$1.60 \times 10^{-19}\ \text{C}$
Planck's constant, h	=	$6.63 \times 10^{-34}\ \text{J} \cdot \text{s}$
Mass of electron, m_e	=	$9.11 \times 10^{-31}\ \text{kg}$
Mass of proton, m_p	=	$1.67 \times 10^{-27}\ \text{kg}$
Boltzmann constant, k	=	$1.38 \times 10^{-23}\ \text{J/K}$
Avogadro's number, N_A	=	$6.02 \times 10^{23}\ \text{mol}^{-1}$
Standard atmosphere pressure, P_0	=	$1.01 \times 10^{5}\ \text{Pa}$
Density of water, ρ_w	=	$1000\ \text{kg/m}^3$
Specific heat (capacity) of water, c_w	=	$4.19 \times 10^{3}\ \text{J/(kg} \cdot {}^\circ\text{C)}$

1. Which of the following is not a universal constant?

   (A) Mass of the electron m_e

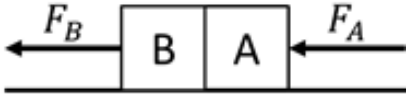
   (B) Speed of the light c

   (C) Acceleration due to gravity at Earth's surface g

   (D) Charge of electron e

   (E) Universal gas constant R

2. Two blocks A and B, of the same mass m, are placed on a smooth horizontal table as shown in the figure below. Forces, F_A and F_B are acting on the two blocks as shown. Given that $F_A > F_B$, the force exerted by block A on block B



   (A) is zero.

   (B) is pointing to the left.

   (C) is pointing to the right

   (D) may be pointing either to the left or to the right.

   (E) is greater than the force exerted by block B on A.

3. Consider two carts, A and B, of masses m and $2m$ respectively, are initially at rest on an air track. If you push both carts with the same force and for the same duration of time, the ratio of final momentum of cart A to final momentum of cart B is

   (A) 1 : 4.

   (B) 1 : 2.

   (C) 1 : 1.

   (D) 2 : 1.

   (E) 4 : 1.

4. Suppose 1.0 kg of clay travelling at speed v smashes into 1.0 kg of clay which is not moving. They stick and become one 2.0 kg lump of clay. What proportion of the kinetic energy in the originally moving lump was turned into heat and sound during the collision?

   (A) 0%
   (B) 25%
   (C) 50%
   (D) 75%
   (E) 100%

5. A particle with mass m and initial speed v_0 is subject to a velocity dependent damping force of the form bv^n where b is a constant. The stopping time can be expressed as $Am^\alpha b^\beta v_0^\gamma$ where α, β and γ are the exponents. A can be assumed to be dimensionless. α, β and γ are respectively

   (A) $1,\ -1,\ 1-n$
   (B) $-1,\ -1,\ n$
   (C) $1,\ 2,\ n$
   (D) $2,\ -1,\ 1-n$
   (E) $-1,\ 1,\ n-1$

6. A boat is traveling in a river at speed v_1 relative to still water, with the speed of the water current as v_2. When the boat steers perpendicularly to the bank at speed v_1, it reaches the opposite bank at time t_1. When the boat steers at an angle upstream such that it will reach directly opposite of its starting point with the same speed, the time taken is t_2. What is the ratio of v_1 to v_2?

   (A) $\dfrac{t_1}{\sqrt{t_2^2+t_1^2}}$
   (B) $\dfrac{t_2}{\sqrt{t_2^2+t_1^2}}$
   (C) $\dfrac{t_1}{\sqrt{t_2^2-t_1^2}}$
   (D) $\dfrac{t_2}{\sqrt{t_2^2-t_1^2}}$
   (E) none of the above

7. A small graphite block stays at rest on a piece of paper. The paper is now moved and both the paper and the block move at the same constant velocity v_0 horizontally. After moving for a time t, the paper stops suddenly. Given that the kinetic friction between the graphite block and the paper is μ, what is the length of the marking that the block made on the piece of paper when the graphite block eventually stops? Assuming the mass loss of the graphite block is negligible throughout the motion.

(A) $\dfrac{v_0^2}{2\mu g}$

(B) $v_0 t$

(C) $v_0 t + \dfrac{1}{2}\mu g t^2$

(D) $\dfrac{v_0^2}{\mu g}$

(E) 0

8. Diane walked into her physics lab to find her demonstrator Erica standing in front of a 10 cm long cylinder floating upright in a tank of a clear fluid as shown in the diagram. They then put the tank with the cylinder in a chamber and increased the air pressure in the chamber to 100 atm while keeping the temperature constant. What will happen to the floating cylinder?

Assume that the fluid is incompressible, and that air is an ideal gas (density= 1.29 kgm^{-3} at 1 atm).

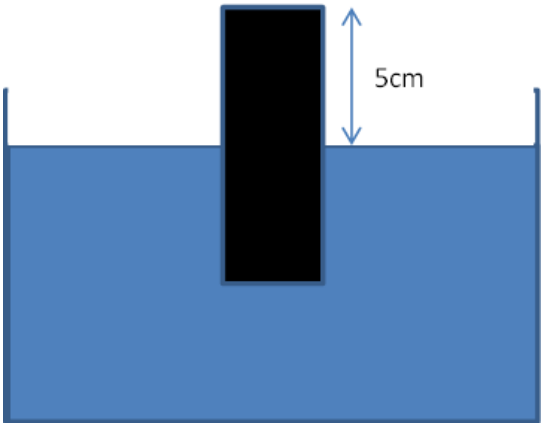
(A) The cylinder will float higher in the liquid by 6 mm.

(B) The cylinder will sink lower in the liquid by 6 mm

(C) The cylinder will float higher in the liquid by 4.4 mm

(D) The cylinder will sink lower in the liquid by 4.4 mm

(E) The cylinder will neither sink lower nor float higher in the liquid.



9. Automobiles are made nowadays to be energy-absorbing in the event of a crash. It means that the components of the body are designed to be anything but elastic, and to be sacrificed while dissipating kinetic energy. Sometimes this is described loosely by the size of the *crumple-zone* ahead or behind the passengers of the car. A Datsun had a crumple zone of roughly 1.5 m, and about 1 m of it had been used up when it hit a concrete wall at about 30 km/hour. What is the minimum force needed to bring the 1000 kg car to rest in this distance?

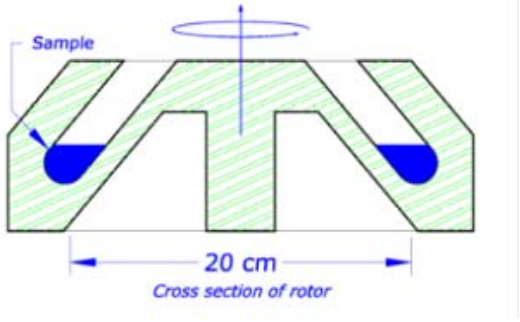
(A) 2.3×10^4 N
(B) 4.5×10^6 N
(C) 3.5×10^4 N
(D) 450 N
(E) 30 N

10. A person rides on a bicycle at 10 m/s heading eastwards. He feels that the wind is blowing from the north at 10 m/s. The velocity of the wind relative to the ground is

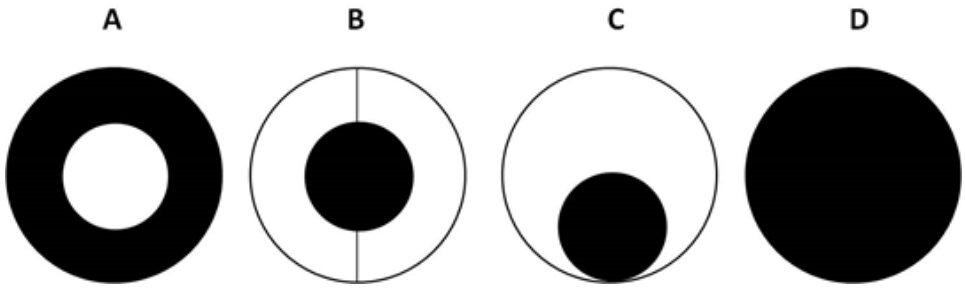
(A) 14 m/s, with direction pointing southwest
(B) 14 m/s, with direction pointing southeast
(C) 10 m/s, with direction pointing north
(D) 10 m/s, with direction pointing south
(E) 20 m/s, with direction pointing northeast

11. Four samples of a colloidal aqueous mixture each weighing 12.0 g are placed in the rotor of a high speed centrifuge, equally spaced around the circumference of the rotor. The samples are located 10 cm from the axis of rotation of the rotor. If the centrifuge motor delivers a constant torque of 0.25 Nm and the empty rotor has a moment of inertia of 0.060 kgm^2, how long does it take for the rotor to accelerate to its operating state of 18000 rpm (rotations per minute)? You may neglect the change in the position of the sample during acceleration.

(A) 7.6 s
(B) 456 s
(C) 453 s
(D) 7.3 s
(E) 435 s



12. Four cylinders with the same mass m, length L and outer radius R but different cross sections as shown in the figure roll down the same slope without slipping from rest at the same time. The shaded regions indicate a uniform distribution of mass, while the unshaded regions are hollow and thin lines (in B) indicate supportive structure that is rigid and negligible in mass or dimension. The inner radius of cylinder A, and the radius of the solid cross sections in B and C are both $R/2$.



Which cylinder will arrive at the bottom of the slope first?

(A) A

(B) B

(C) C

(D) D

(E) They arrive at the same time.

13. In the diagram below, the man (of mass m) is at the same initial horizontal level as the counterweight (also of mass m). As the man accelerates and starts to climb up the rope, which of the following correctly reflects the motion of the man and the counterweight? We need not consider the mass of the rope nor the friction in the pulley system.

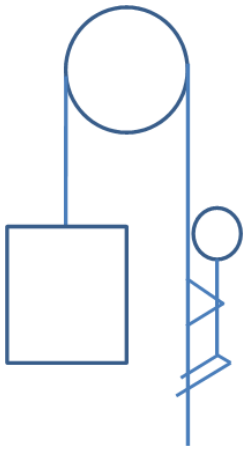
(A) The man accelerates upwards and the counterweight accelerates downwards.

(B) The man accelerates upwards and the counterweight does not move.

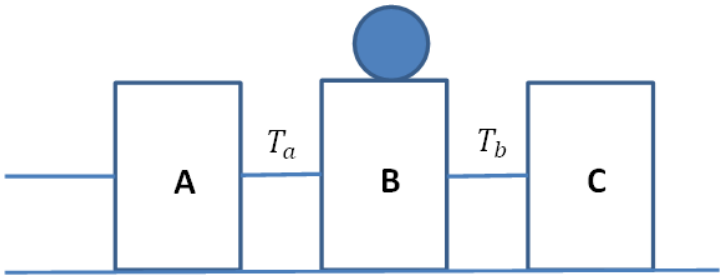
(C) The man and the weight accelerates together upwards and reaches the ceiling at the same time.

(D) The man and the weight accelerates together upwards but the man moves more speedily then the weight.

(E) The man and weight accelerates together upwards but the weight moves more speedily than the man.



14. A force F is used to pull 3 objects A, B, C across a frictionless surface. The three objects are connected by strings. When a small object is placed on top of B and with force F unchanged, what will happen to the tensions T_a and T_b respectively?



(A) T_a increases and T_b decreases

(B) T_a increases and T_b increases

(C) T_a decreases and T_b decreases

(D) T_a decreases and T_b increases

(E) T_a and T_b remains the same

15. A particle exhibiting uniform circular motion with radius r has its speed increased 3 times and the centripetal force is hence increased by 64 N. The original centripetal force is

(A) 16 N

(B) 12 N

(C) 8 N

(D) 6 N

(E) 18 N

16. Which of the following about static friction is correct?

(A) There is always a non-zero static friction between two stationary objects in contact with each other.

(B) The static friction between two objects is always greater than the kinetic friction between these two objects.

(C) The direction of the static friction must be in the direction of motion.

(D) Depending on the forces applied to an object in contact with another object, the value of static friction can change.

(E) When the normal force on the object increases, the static friction must increase.

17. A U shaped glass tube consists of two open-ended vertical glass tubes of height h and a horizontal tube of length $2h$ joined together. Diameter of the tube is much smaller than h, and the horizontal tube is initially filled with mercury with density ρ as shown below. The atmospheric pressure is p_0. Subsequently the two ends of the tube are sealed. The tube is then accelerated to the right until the mercury occupies a length of $(5/3)h$ inside the horizontal tube. The acceleration of the tube is

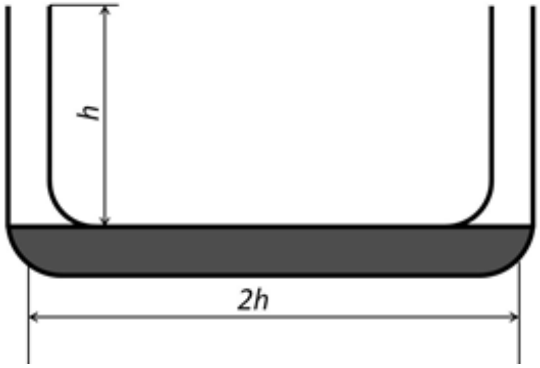
(A) $\dfrac{g}{5}$

(B) $\dfrac{3p_0 + \rho g h}{5\rho h}$

(C) $\dfrac{27p_0 + 4\rho g h}{20\rho h}$

(D) $\dfrac{9p_0 - 4\rho g h}{20\rho h}$

(E) $\dfrac{9p_0 + 4\rho g h}{20\rho h}$



18. Two masses, m_1 and m_2, are joined by a massless spring of force constant k and placed on a horizontal frictionless surface. The system is released from rest when the separation between the masses is x. if the unstretched length of the spring is x_0, the speed of the mass m_1 when the two masses are at the distance x_0 apart is

(A) $\sqrt{\dfrac{k}{m_1}(x - x_0)^2}$

(B) $\sqrt{\dfrac{k}{m_2}(x - x_0)^2}$

(C) $\sqrt{\dfrac{k}{m_1 - m_2}(x - x_0)^2}$

(D) $\sqrt{\dfrac{k}{m_1}\dfrac{m_2}{m_1 + m_2}(x - x_0)^2}$

(E) $\sqrt{\dfrac{k}{m_2}\dfrac{m_1}{m_1 + m_2}(x - x_0)^2}$

19. In a room without air-conditioning, a ceiling fan with varying power may be used. When we consider the pulling force on the ceiling by the fan, as compared to weight of the fan, which of the following statement is correct?

(A) When the fan is operating at high power, the pulling force is equal to the weight.

(B) When the fan is operating at low power, the pulling force is greater than the weight.

(C) The pulling force is equal to the weight, irrespective of the output power of the fan.

(D) The pulling force is smaller than the weight, irrespective of the output power of the fan.

(E) The pulling force is greater than the weight, irrespective of the output power of the fan.

20. A fast moving small bullet of mass m hits and passes through a heavy stationary wooden block of mass M. When the bullet passes through the block,

(A) M and m experience the same impulse.

(B) The mutual force between the bullet and the wooden block will do the same amount of work.

(C) The bullet's speed will reduce by the same amount as the increase in the wooden block's speed.

(D) The bullet's momentum will reduce by the same amount as the increase in the wooden block's momentum.

(E) The bullet's temperature will increase by the same amount as the increase in the wooden block's temperature.

21. An ideal gas exerts a pressure of 60 Pa when its temperature is 400 K and the number density of molecules is n. Another sample of the same gas exerts a pressure of 30 Pa when its temperature is 300 K. How many molecules are present in unit volume of this second sample?

(A) $4n/3$

(B) $3n/2$

(C) $3n/4$

(D) $2n/3$

(E) $n/2$

The next 2 questions use the information given in the paragraph below.

Green Light of wavelength 500 nm and of intensity 0.50 W/m^2 is shone on a solar cell of area 0.040 m^2. The solar cell generates sufficient power to drive a small microfluidic device that heats 0.050 g of water from 300 K to 301 K in 1.0 minute.

22. The number of photons that reach the solar cell per second is

(A) 5.0×10^{16}

(B) 5.0×10^{10}

(C) 6.0×10^{28}

(D) 6.0×10^{20}

(E) 5.0×10^{18}

23. What is the efficiency of the solar cells in this case? You can ignore the electrical resistance in the wires.

(A) 0.18%

(B) 11%

(C) 18%

(D) 35%

(E) 100%

24. The crest of a Parasaurolophus dinosaur skull contains a nasal cavity (its bony crest) that forms a long tube open at one end. The dinosaur is believed to have produced sound by passing air through the cavity and setting up the fundamental mode in it. By modeling the cavity as a tube open at one end and 2.50 m in length, what fundamental frequency and first harmonic could have been produced? Take the speed of the sound in air to be 340 ms^{-1} and ignore edge effects.

(A) 136 Hz, 272 Hz

(B) 34 Hz, 138 Hz

(C) 34 Hz, 102 Hz

(D) 68 Hz, 102 Hz

(E) 68 Hz, 138 Hz

25. White light, consisting of all wavelengths between 400 nm and 700 nm shines through a diffraction grating with 150 lines/mm, separating into a spectrum of colour on a screen 2.50 m away. The first observed colour of the third order rainbow, as measured from the center of the screen, lines up with one of the wavelength, λ_2 of the second order rainbow. What is λ_2?

(A) 400 nm

(B) 450 nm

(C) 500 nm

(D) 600 nm

(E) 700 nm

26. As shown below, two nails A and B are placed with a separation $\Delta = 0.30$ cm when observed along the normal to the straight line l. A piece of glass with thickness $d = 1.00$ cm and continuous density is then placed between the nails at $\theta = 45°$ to the line l. The two nails now seem to be along the same line when observed normal to l. The index of refraction of the glass is

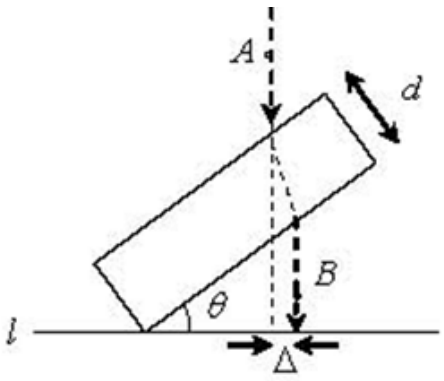
(A) 1.33

(B) 1.41

(C) 1.50

(D) 1.62

(E) 1.73



27. A monochromatic light ray in air ($n = 1.0$) enters a glass prism ($n = 1.5$). In the glass prism

(A) both the frequency and the wavelength are the same as in air.

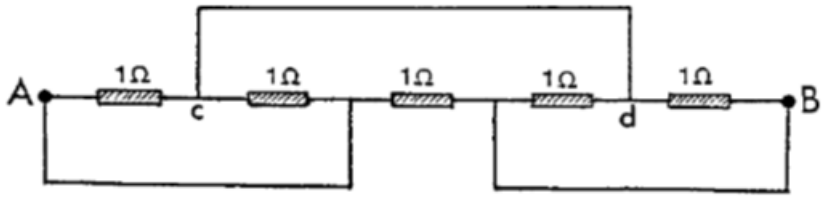
(B) the frequency is the same but the wavelength is smaller than in air.

(C) the frequency is the same but the wavelength is larger than in air.

(D) the wavelength is the same but the frequency is smaller than in air.

(E) the wavelength is the same but the frequency is larger than in air.

28. Determine the resulting resistance R between **A** and **B** as in the diagram below. Resistance in the wires are negligible.



(A) 0.20 Ω

(B) 0.25 Ω

(C) 0.50 Ω

(D) 1.00 Ω

(E) 1.25 Ω

29. An alpha particle (a He nucleus, containing two protons and two neutrons and having a mass of 6.64×10^{-27} kg) travelling horizontally at 35.6 km/s enters a uniform, vertical 1.10 T magnetic field. What is the diameter of the path followed by this alpha particle?

(A) 0.67 mm

(B) 1.34 mm

(C) 1.58 mm

(D) 2.15 mm

(E) 5.36 mm

30. You require a 2.0 g copper sphere with a charge of exactly +3.0 μC. What fraction of the electrons must be removed from this copper sphere in order to give it the stated charge? Atomic number of copper is 29; mass number of copper is 63.5.

(A) 1.6×10^{-11}

(B) 7.4×10^{-11}

(C) 1.7×10^{-11}

(D) 9.9×10^{-10}

(E) 3.4×10^{-11}

31. An equilateral triangle has charges placed on the three apex. $-2q$ is placed at point A, $+q$ each placed on B and C, $q > 0$. The center of the triangle is at point O, and point P is its mirror image about line BC. Which of the following statements is correct?

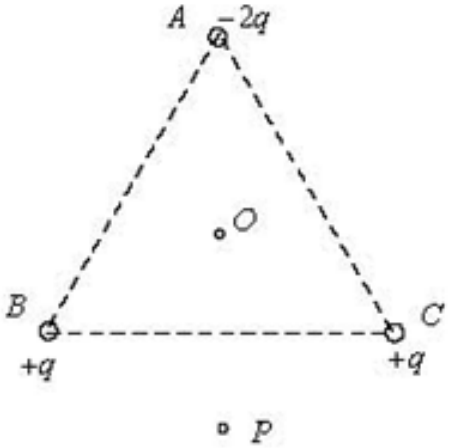
(A) Electric field is zero at point O.

(B) Electric potential at point O is higher than that at point P.

(C) Electric field at point O is stronger than that at point P.

(D) Electric field along the line PO always points from P to O.

(E) An external force that separates the three charges slowly till infinitely apart would have done negative total work.



32. The readings from the voltmeter and ammeter from the circuit shown below are

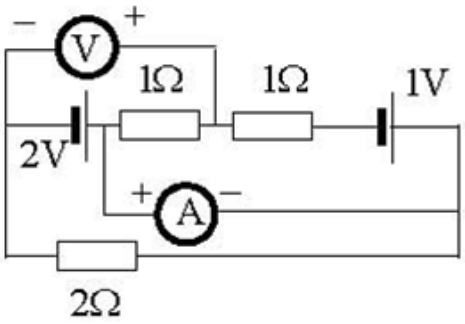
(A) 2.0 V, 1.0 A

(B) 1.0 V, 0.5 A

(C) 1.5 V, 0.5 A

(D) 1.5 V, 1.0 A

(E) 1.0 V, 2.0 A



33. As shown in the diagram, a, b, c are three concentric circular wire loops with radii $R_a < R_b < R_c$. The three loops have the same resistances. When a clockwise current through a is suddenly increased, the induced current in loops b and c is

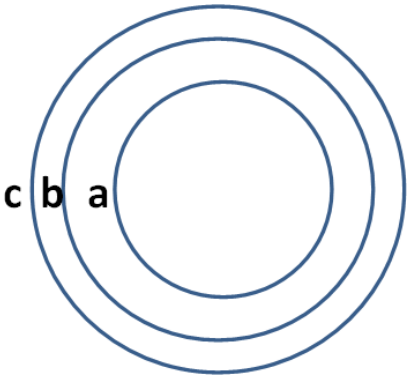
(A) Clockwise, $i_b > i_c$

(B) Anti-clockwise, $i_b > i_c$

(C) Clockwise, $i_b < i_c$

(D) Anti-clockwise, $i_b < i_c$

(E) Zero



34. When a light bulb is connected to a constant D.C. source, the output power is 40 W. If the light bulb is connected to the same source in series with another resistor R, the output power of the resistor is 3.6 W. Take the resistance of the light bulb to be a constant smaller than R, the output power of the light bulb now is closest to

(A) 0.3 W

(B) 0.9 W

(C) 14.4 W

(D) 16.4 W

(E) 32.4 W

35. The figure below shows a reed switch which consists of a pair of springy contacts made from magnetic material sealed in a glass tube. The reed switch can be placed in a coil to form a relay switch whereby current in the coil controls the opening and closing of the switch. Which of the following phenomena is not utilized in a reed switch relay?

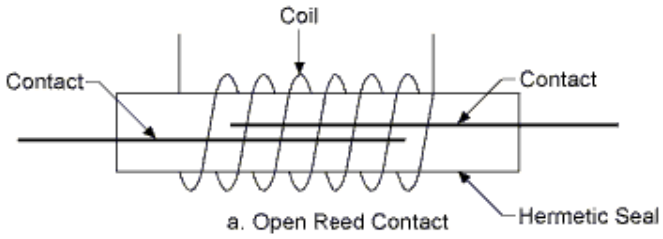
(A) Magnetic field of a current

(B) Effect of magnetic field on a current

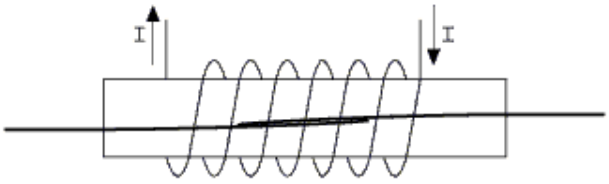
(C) Interaction between magnetic poles

(D) Magnetization

(E) None of the above



a. Open Reed Contact



b. Closed Reed Contact

36. If the mass of a planet is doubled while its radius and the radius of orbit of its moon remain unchanged, the speed of the moon is

(A) increased by a factor of $\sqrt{2}$

(B) increased by a factor of 2.

(C) not changed.

(D) reduced by a factor of $\sqrt{2}$

(E) reduced by a factor of 2.

37. An ideal gas is heated such that it expands at constant pressure. The gas does work W. What is the amount of heat added to the gas?

(A) W
(B) $-W$
(C) zero
(D) more than W
(E) less than W

38. In the equation $pV = nRT$,

(A) T is measured in degrees Celsius.
(B) R is the resistance of the system.
(C) R has different values for different gases.
(D) V is the velocity of the flowing gas.
(E) n is the number of moles of gas.

39. The oxygen (molar mass = 32 g/mol) and nitrogen (molar mass = 28 g/mol) molecules in this room have equal average

(A) kinetic energies, but the oxygen molecules are faster.
(B) kinetic energies, but the oxygen molecules are slower.
(C) kinetic energies and speeds.
(D) speeds, but the oxygen molecules have a higher average kinetic energy.
(E) None of the above is correct.

40. An aquarium contains a 5-cm layer of water ($n = 1.33$) floating on top of carbon tetrachloride ($n = 1.461$). The angle of incidence into the water from the air is 30°, what is the angle of refraction into the carbon tetrachloride?

(A) 11°
(B) 15°
(C) 20°
(D) 23°
(E) 30°

41. You may have noticed that when you get out of the swimming pool and stand dripping wet in a light breeze, you feel much colder than you would feel after you dry off. Why is this?

(A) The moisture on your skin has good thermal conductivity.

(B) Water has a relatively large specific heat capacity.

(C) This is purely a psychological effect resulting from the way in which sensory nerves in the skin are stimulated.

(D) The water on your skin is colder than the surrounding air.

(E) Heat is required to evaporate water from your skin and most of this heat comes from your body.

42. If you have ever had to wade across a rocky creek while hiking in the mountains, you would have probably noticed that by the time you get to the deep water in the centre of the creek the rocks do not seem to hurt your bare feet so much. What is the reason for this?

(A) The greater pressure on one's feet in deep water means that the rocks cannot dig in so much.

(B) The velocity of the water is less in deep regions than in shallow regions.

(C) One tends to stand on tiptoe in deep water, thereby reducing the area of the foot in contact with the rocks.

(D) Deeper water is colder, and hence more dense, than shallow water.

(E) One experience a greater buoyant force (upthrust) in deeper water.

43. An ocean wave directed straight in strikes a sea wall perpendicularly to its path and is reflected. The incoming wave travels 0.79 m/s and has a period of 4.8 s. The wave has an antinode at the wall. How far from the wall is the nearest node in the standing wave setup?

(A) 0.95 m

(B) 0.47 m

(C) 0.71 m

(D) 1.4 m

(E) 0.76 m

44. Which of the following is an accurate statement?

(A) A system like a vibrating string has only one resonant frequency.

(B) In order for a singer to break a wine glass by singing, she must adjust the amplitude of the sound she makes so that it is exactly equal to the amplitude of vibration of the wine glass.

(C) The resonant frequency of a system is the name given to the lowest possible frequency at which the system will naturally vibrate.

(D) The organ pipe has an infinite number of resonant frequencies.

(E) When an oscillatory system is driven by a sinusoidal force, the response amplitude of the system will be the same as the amplitude of the driving force.

45. Two uncharged metal spheres, A and B, are mounted on insulating support rods. A third metal sphere, C, carrying a positive charge, is then placed near sphere B. Now a copper wire is momentarily connected between A and B and then removed. Finally, sphere C is removed. In this final state,

(A) spheres A and B are still uncharged.

(B) sphere A carries positive charge while B carries negative charge.

(C) sphere A carries negative charge while B carries positive charge.

(D) spheres A and B both carry positive charge.

(E) spheres A and B both carry negative charge.

46. In Bohr's model for hydrogen atom, the energy levels are $E_n = -13.6/n^2$ eV. Given the product of speed of light and Planck's constant $hc = 1.24 \times 10^{-6}$ eVm , and the elementary charge is $e = 1.6 \times 10^{-19}$ C, which of the following wavelength cannot be produced by energy transition of a hydrogen atom?

(A) 82 nm

(B) 122 nm

(C) 397 nm

(D) 410 nm

(E) 102 nm

47. Two identical bar magnets are dropped from equal heights. Magnet A is dropped from above bare earth, whereas magnet B is dropped from above a copper plate. Which magnet will strike the surface first?

(A) Magnet A
(B) Magnet B
(C) Both will strike at the same time.
(D) Whichever has the N pole toward the ground.
(E) Whichever has the S pole toward the ground.

48. Of the several nuclear reactions listed below, which is possible? (α, β and γ stands for alpha, beta and gamma radiation/particle respectively.)

(A) ${}^{10}_{5}\mathrm{B} + \alpha \rightarrow {}^{13}_{7}\mathrm{N} + {}^{1}_{1}\mathrm{H}$
(B) ${}^{22}_{11}\mathrm{Na} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{20}_{10}\mathrm{Ne} + \alpha$
(C) ${}^{10}_{5}\mathrm{B} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{11}_{6}\mathrm{C} + \beta + \gamma$
(D) ${}^{14}_{7}\mathrm{N} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{12}_{6}\mathrm{C} + \beta + \gamma$
(E) None of the above is correct.

49. If a charged pion that decays in 10^{-8} second in its own rest frame is to travel 30 m in the laboratory before decaying, the pion's speed must be most nearly

(A) 0.43×10^8 m/s
(B) 2.84×10^8 m/s
(C) 2.90×10^8 m/s
(D) 2.98×10^8 m/s
(E) 3.00×10^8 m/s

50. Is it possible for the momentum of an object of mass m to be mc where c is the speed of light in vacuum?

(A) No, because no object can travel at speed c to achieve that.
(B) No, only massless objects can travel at speed of light.
(C) Yes, some special massive objects can travel at speed c and will have this momentum.
(D) Yes, if its speed $v = 0.8c$
(E) Yes, if the speed $v = c/\sqrt{2}$

END OF PAPER.