SINGAPORE JUNIOR PHYSICS OLYMPIAD 2015
GENERAL ROUND

29 July, 2015

3:00 pm – 4:30 pm

Time Allowed: ONE hour THIRTY minutes

INSTRUCTIONS

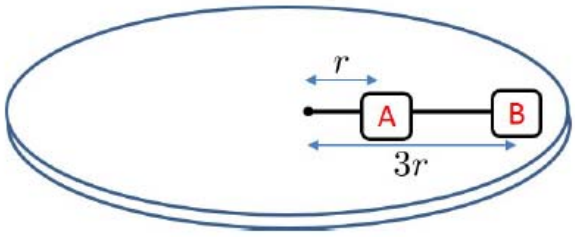
1. This paper contains **50** multiple choice questions and **23** printed pages.
2. Each of the questions or incomplete statements is followed by five suggested answers or completions. Select the one that is best in each case and then shade the corresponding bubble on the answer sheet.
3. Only the answer 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	=	$9.80\ \mathrm{m/s^2}$
Universal gas constant, R	=	$8.31\ \mathrm{J/(mol \cdot K)}$
Vacuum permittivity, ϵ_0	=	$8.85 \times 10^{-12}\ \mathrm{C^2/(N \cdot m^2)}$
Vacuum permeability, μ_0	=	$4\pi \times 10^{-7}\ \mathrm{T \cdot m/A}$
Atomic mass unit, u	=	$1.66 \times 10^{-27}\ \mathrm{kg}$
Speed of light in vacuum, c	=	$3.00 \times 10^{8}\ \mathrm{m/s}$
Charge of electron, e	=	$1.60 \times 10^{-19}\ \mathrm{C}$
Planck's constant, h	=	$6.63 \times 10^{-34}\ \mathrm{J \cdot s}$
Mass of electron, m_e	=	$9.11 \times 10^{-31}\ \mathrm{kg}$
Mass of proton, m_p	=	$1.67 \times 10^{-27}\ \mathrm{kg}$
Boltzmann constant, k	=	$1.38 \times 10^{-23}\ \mathrm{J/K}$
Avogadro's number, N_A	=	$6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
Standard atmosphere pressure, P_0	=	$1.01 \times 10^{5}\ \mathrm{Pa}$
Density of water, ρ_w	=	$1000\ \mathrm{kg/m^3}$
Specific heat (capacity) of water, c_w	=	$4.19 \times 10^{3}\ \mathrm{J/(kg \cdot {}^\circ C)}$
Latent heat of fusion of water, L_f	=	$3.33 \times 10^{5}\ \mathrm{J/kg}$
Latent heat of vaporization of water, L_v	=	$2.26 \times 10^{6}\ \mathrm{J/kg}$

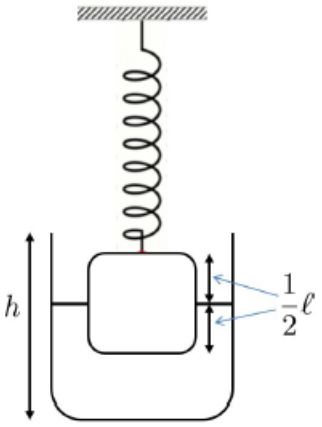
1. Two identical masses, A and B, are tied to strings and placed on a horizontal frictionless disc as in the figure below. The two masses are then set to move about the centre of the disc with the same angular velocity ω. Given that the tension of the string connecting mass A to the center of the disc is T, determine the tension of the string connecting mass B to mass A.

(A) $T/4$
(B) $3T/4$
(C) T
(D) $3T$
(E) $4T$

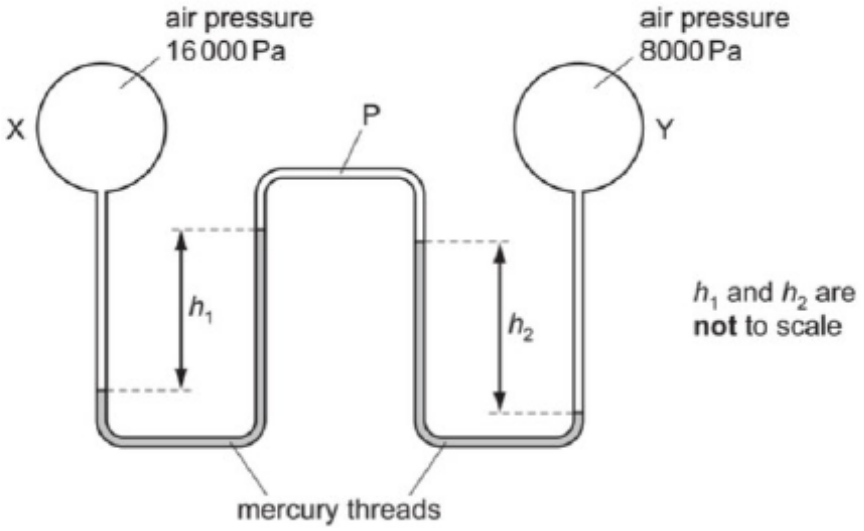


2. A cube is attached to a spring and allowed to be half immersed in a beaker of liquid, as shown in the diagram below. The density of the cube is higher than that of the liquid. Let the volume of the beaker be $A \times h$, the volume of the cube be l^3 and the spring constant be k. At this point, the extension of the spring is x. The acceleration of gravity is denoted as g. An additional volume of the same liquid is now poured into the beaker until the cube is fully submerged. The extension of the spring changes to x'. Besides some of the other variables, i.e., l, A, k, g and h, given in this question, which other quantity do we need to know if we want to compute the difference between the two extensions, $x - x'$?

(A) Density of the cube only.
(B) Density of the liquid only.
(C) Ratio of the densities of the cube and the liquid only.
(D) Difference between the densities of the cube and the liquid only.
(E) Mass of the cube.



3. Two bulbs X and Y are connected by a tube P as shown below. Both bulbs have different air pressure, and there is a non zero pressure in P. Which of the following are possible values of h_1 and h_2 (in cm)?



(A) $h_1 = 9,\ h_2 = 18$

(B) $h_1 = 18,\ h_2 = 9$

(C) $h_1 = 10,\ h_2 = 18$

(D) $h_1 = 18,\ h_2 = 10$

(E) $h_1 = 18,\ h_2 = 18$

4. Gears A, B, C are aligned side by side in such a way that rotating gear A causes gear B to rotate which in turn causes gear C to rotate. Gear A has 40 number of teeth and is rotating at angular speed of 50 rev/s. The radius of gear B is 20% of gear C and gear C is rotating at 40% angular speed of gear A. All the gears have the same tooth and groove size. How many teeth does gear B have?

(A) 10

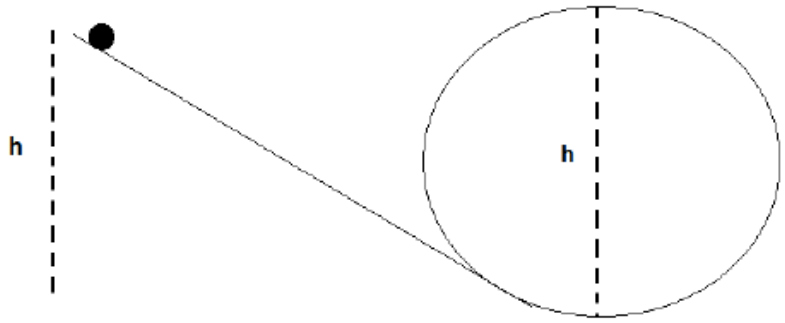
(B) 20

(C) 40

(D) 50

(E) 80

5. An ball is placed on a roller coaster track, as shown in the following figure:



The object is initially at a height h above the ground. The track has a loop, which can be assumed to be in a form of a circle with diameter h. You may assume there is no friction between the object and the track. Which of the following statements is correct?

(A) The object will be able to undergo one full loop along the track.

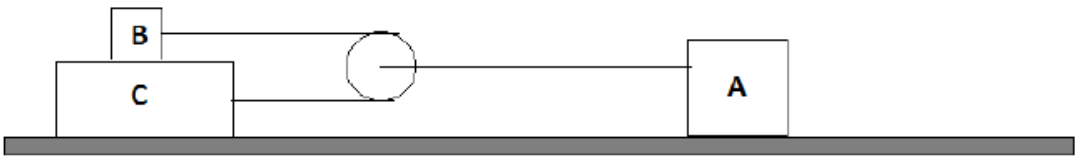
(B) The object will stop when it reaches the top of the loop.

(C) The object will not be able to reach the top of the loop.

(D) The object will oscillate about the bottom part of the loop.

(E) The total energy of the object increases because of gravity.

6. Three blocks A, B, and C are placed on the table and attached to one another according to the figure below.



Suppose block A is pulled to the right, so that it moves to the right with acceleration a_A. It is observed that both block B and C are also moving to the right with acceleration a_B and a_C, respectively, with $a_B < a_C$. Find the relationship between a_A, a_B, and a_C.

(A) $a_C + a_B = 2a_A$

(B) $a_C - a_B = 2a_A$

(C) $a_C + a_B = a_A$

(D) They are independent.

(E) There is not enough information.

7. A block is placed on a smooth horizontal surface when a bullet hit it along the horizontal direction. The bullet stayed in the block at the depth d. The friction between the block and the bullet is f. The block moved over a distance of L from the moment it was hit till the bullet is stuck. During the process, which of the statements is correct?

   (A) The kinetic energy of the block is increased by $f(L+d)$.

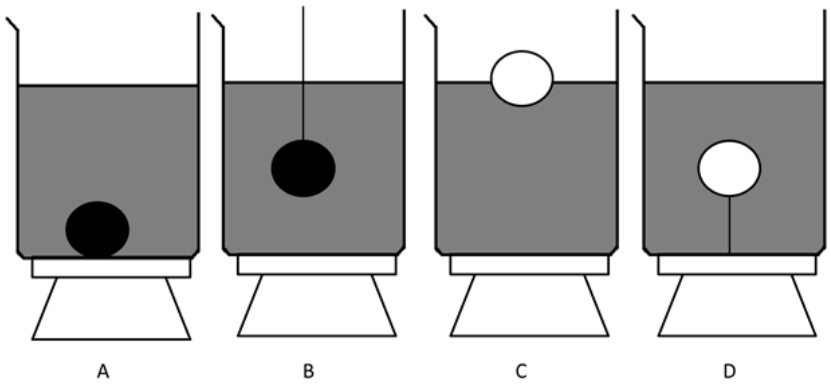
   (B) The kinetic energy of the bullet is reduced by fL.

   (C) The mechanical energy of the system is reduced by fd.

   (D) The mechanical energy of the system is reduced by $f(L+d)$.

   (E) None of the above

8. A beaker is placed on a weighing balance and four small spheres of the same size but different materials were placed in the beaker in turn. Spheres A and B are made of aluminium, Spheres C and D are made of styrofoam. Sphere B was hang from an inextensible string while Sphere D was attached to the bottom of the beaker by a light inextensible string so that both spheres were completely submerged in the middle of the beaker. For each sphere, it was released from the middle of the beaker and the weighing balance reading was taken after equilibrium was reached.



   Which of the following statements are true with regard to the weighing balance readings W_A, W_B, W_C and W_D?

   (A) $W_A > W_B > W_C > W_D$

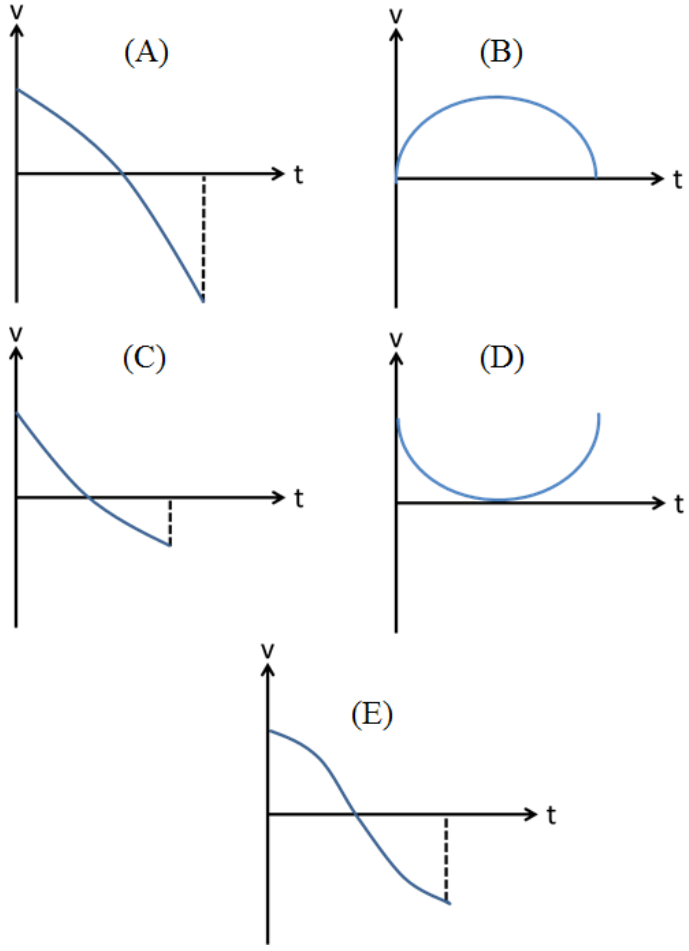
   (B) $W_A > W_B > W_D > W_C$

   (C) $W_A > W_B = W_D > W_C$

   (D) $W_A > W_B > W_C = W_D$

   (E) none of the above

9. An object is thrown upwards from the ground, and caught again when it fell back to the same place. Which of the following graphs most closely represent the velocity-time relationship during this process?



10. At a point out of Earth and at a distance x from its center, the Earth's gravitational field is about 5 N kg^{-1}. At the Earth's surface, the field is about 10 N kg^{-1}. Which of the following gives an approximate value of the radius of the Earth?

(A) $x/5$
(B) $x/(2\sqrt{2})$
(C) $x\sqrt{2}$
(D) $x/\sqrt{2}$
(E) $2x$

11. A force $\vec{F}$ is resolved into two components $\vec{F}_1$ and $\vec{F}_2$. Only the magnitude of $\vec{F}_1$ and the direction of $\vec{F}_2$ are known. Which of the following is the most accurate statement?

(A) Only one combination of $\vec{F}_1$ and $\vec{F}_2$ exists.

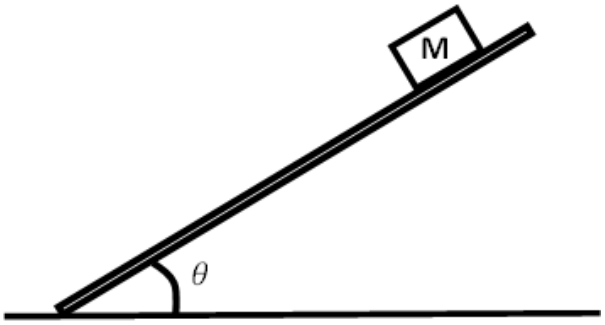
(B) There exists exactly two combinations of $\vec{F}_1$ and $\vec{F}_2$.

(C) There exists infinite combinations of $\vec{F}_1$ and $\vec{F}_2$.

(D) At least three combinations of $\vec{F}_1$ and $\vec{F}_2$ exist but the total number of combinations is finite.

(E) Only one or two combinations of $\vec{F}_1$ and $\vec{F}_2$ exist.

12. As shown in the figure below, the block with mass M is stationary upon the plank and the angle of the slope θ is increased. Which of the following is true for the normal force of the block on the wooden plank, N and the frictional force on the plank, f?



(A) Both N and f increase.

(B) Both N and f decrease.

(C) N increases and f decreases.

(D) N decreases and f increases.

(E) The response differs when the value of M is different.

13. An object is travelling on a straight path and exhibiting a constant acceleration a starts off with an initial velocity $v = 2.0$ ms^{-1}. It has traversed 4.5 m in the third second, its acceleration a is

(A) 0.5 ms^{-2}

(B) 1.0 ms^{-2}

(C) 1.5 ms^{-2}

(D) 2.0 ms^{-2}

(E) 2.5 ms^{-2}

14. A boat is travelling towards the east with speed v_1. If two objects of equal masses m are simultaneously ejected from the boat with speed v (relative to ground) towards the east and the west, which of the following is true?

(A) The speed of the boat increases.

(B) The speed of the boat decreases.

(C) The boat changes direction and speeds up.

(D) The boat changes direction and slows down.

(E) There is no change to the speed of the boat.

15. A ball of mass m is dropped from a height, H. At the point where its potential energy is equal to its kinetic energy, its instantaneous power is

(A) $m\sqrt{gH}$

(B) $m\sqrt{(H/g)}$

(C) $mg\sqrt{gH}$

(D) $\sqrt{gH}/m$

(E) mgH

16. As shown in the diagram, a pendulum of length L is hung from the ceiling and at a point P, a peg is placed. L' denotes the shortened length of the pendulum during part of its oscillation. The period of the pendulums oscillation is now

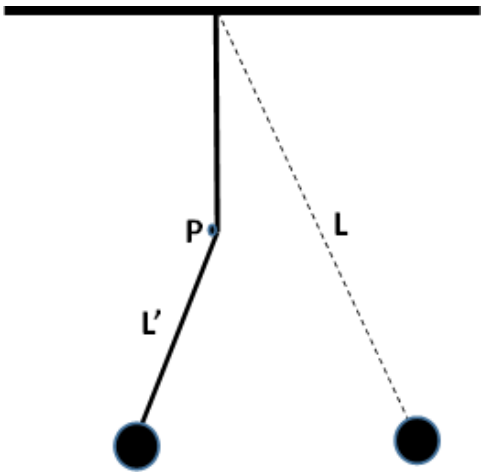
(A) $2\pi\sqrt{\dfrac{L}{g}}$

(B) $2\pi\sqrt{\dfrac{L'}{g}}$

(C) $2\pi\left[\sqrt{\dfrac{L}{g}}+\sqrt{\dfrac{L'}{g}}\right]$

(D) $\pi\left[\sqrt{\dfrac{L}{g}}+\sqrt{\dfrac{L'}{g}}\right]$

(E) $\pi\sqrt{\dfrac{L+L'}{g}}$



17. A hollow triangular holder of mass M, with a ball of mass m affixed to its interior via two massless springs, is placed vertically on a table, as shown in the diagram below. The ball is then made to vibrate up and down. At the instant when the normal contact forces between the table and the holder become zero, the acceleration of the ball is

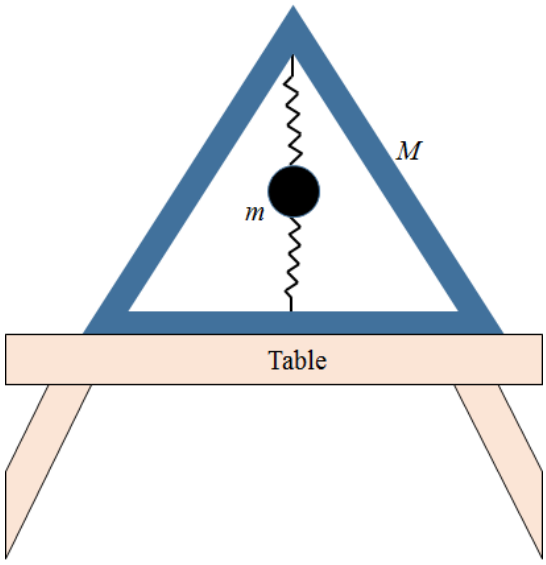
(A) upwards, $\frac{M}{m}g$

(B) downwards, $\frac{M+m}{m}g$

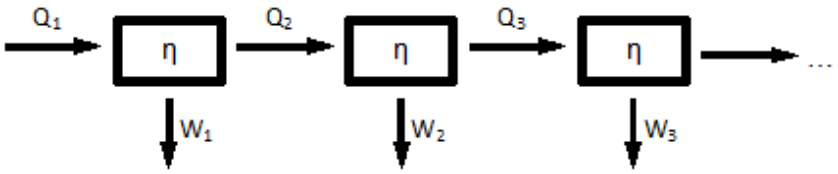
(C) downwards, g

(D) zero

(E) upwards, g



18. A heat engine takes in and converts part of the heat into mechanical work. The efficiency, η or the work done per unit heat input of one such engine is 1/3. Suppose all the waste heat from one engine can be channelled into the subsequent similar engine as heat input, what is minimum engine units required to convert 99.99% of the original heat input into work?



(A) 9

(B) 16

(C) 23

(D) 34

(E) 67

19. An ideal gas of volume 1.5×10^{-3} m^3 and at pressure 1.0×10^5 Pa is supplied with 70 J of energy. The volume increases to 1.7×10^{-3} m^3, the pressure remains constant. The internal energy of the gas is

(A) increased by 90 J

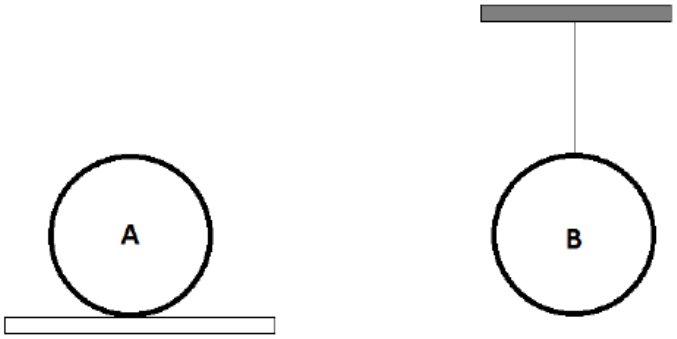
(B) increased by 70 J

(C) increased by 50 J

(D) decreased by 50 J

(E) decreased by 80 J

20. Two identical metal balls A and B, initially have the same radius R and temperature T. Ball A is placed on an insulating table, while ball B is hung by an insulating string, and the two balls are isolated, as shown in the figure below.



Suppose now the two balls are heated for 5 minutes. You may assume that the two balls absorb the same amount of heat. Let the final temperatures of ball A and B be denoted by T_A and T_B respectively. Which of the following statements is correct?

(A) Both temperatures remains the same, i.e., $T_A = T_B = T$

(B) Both temperatures increase, with $T_A = T_B > T$

(C) Both temperatures increase, with $T_A > T_B > T$

(D) Both temperatures increase, with $T_B > T_A > T$.

(E) Both balls will contract.

21. In a gas of N diatomic molecules, there are two possible models for a classical description of a diatomic model. These 2 models are shown below.

Which of the following statements is true?

(A) Model I will result in the molar heat capacity of the gas being $\frac{3}{2}R$, where R is the universal gas constant.

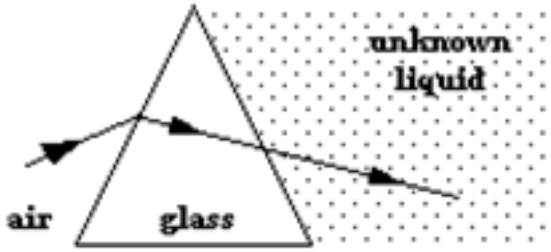
(B) Model I has a smaller specific heat capacity than that of model II.

(C) Model II is always correct.

(D) Model I is always correct.

(E) We can choose either model I or model II depending on the temperature.

22. A ray of red light travels through air and is refracted as it enters a glass prism as shown in the figure. An unknown liquid is in contact with the right side of the prism. The light then follows the path shown. Which one of the following statements concerning this situation is true?



(A) The speed of light is greater in the unknown liquid than in the glass prism.

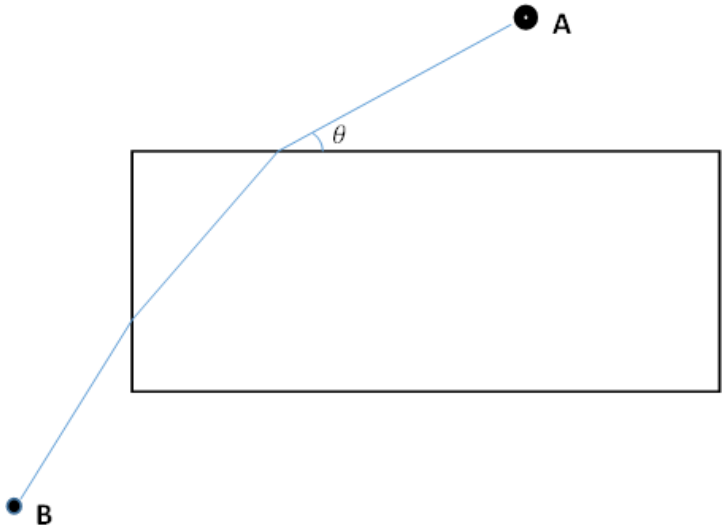
(B) The frequency of the light changes inside the glass prism.

(C) The refractive index of the glass prism is smaller than that of air.

(D) The refractive index of the unknown liquid is the same as that of air.

(E) The refractive index of the unknown liquid is the same as that of the glass prism.

23. To model the formation of a 'cumzenithal arc' in the sky, we consider the following geometry. Sunlight enters from the top of an ice crystal and exits from the side, as shown in the diagram below. What is the maximum angle of θ above which no ray from point A will reach point B? (Take the refractive index of ice to be 1.31.)



(A) 32

(B) 58

(C) 50

(D) 16

(E) 44

24. Which of the listed phenomena best illustrates the fact that light is a transverse wave?

(A) A beam of light in air is bent towards the normal upon entering water.

(B) When a beam of light passes through a small circular aperture and onto a screen, the size of the spot of light on the screen increases as the aperture size decreases.

(C) A beam of laser light passing through 2 closely spaced slits produces a series of bright and dark fringes.

(D) A beam of sunlight that has passed through one polariser is blocked by a second polariser whose polarisation axis is perpendicular to that of the first.

(E) A beam of light exerts a pressure on the surface it falls on.

25. In a pipe that is closed at one end and open at the other, a 425-Hz tuning fork resonates when the pipe is 40-cm long; this tuning fork does not resonate for any smaller pipes. For which of these closed pipe lengths will this tuning fork also resonate?

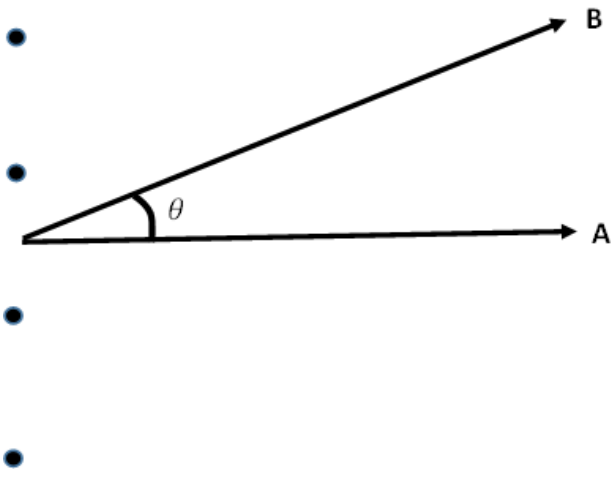
(A) 20 cm
(B) 80 cm
(C) 120 cm
(D) 160 cm
(E) 425 cm

26. A travelling wave is described by the following equation, where x is in metres and t is in seconds. What is the velocity of the wave?

$$y = 4.0\sin(2.0x + 5.0t)$$

(A) 0.4 ms^{-1} to the left
(B) 2.5 ms^{-1} to the left
(C) 20 ms^{-1} to the left
(D) 0.4 ms^{-1} to the right
(E) 2.5 ms^{-1} to the right

27. The equally spaced vertical radio antenna shown in the diagram below (not drawn to scale) transmit equally and in phase at 10^6 Hz. If signals of equal intensity are received at A and at B, 50 kilometers away from each other and about 100 kilometers from the source, a possible spacing between the two adjacent antenna are



(A) 110 m
(B) 168 m
(C) 335 m
(D) 340 m
(E) 670 m

28. The Moon is approximately 380,000 km from Earth. The time a laser light beam takes to travel from the Earth to the Moon and back is most nearly

(A) 2 microseconds.

(B) 2 milliseconds.

(C) 2 seconds.

(D) 2 minutes.

(E) 2 hours.

29. An object is placed 6.0 cm from a converging lens of focal length 9.0 cm. What is the magnitude of the magnification of the image produced?

(A) 0.6

(B) 1.5

(C) 2.0

(D) 3.0

(E) 3.6

30. MgF_2 has a refractive index of 1.38 relative to air. In order to minimize reflection of light with wavelength 550 nm from a glass lens, a layer of MgF_2 is coated on the lens. This layer of MgF_2 has a thickness of

(A) 100 nm

(B) 138 nm

(C) 275 nm

(D) 550 nm

(E) 825 nm

31. A transverse wave is travelling past two points A and B on a horizontal straight line. Two point particles under the influence of the wave are situated at A and B respectively, 60 cm apart. When the particle at point A is at moving upwards, the particle at point B is at the trough. If the speed of the wave is 24 m/s, the frequency of the wave cannot be

(A) 30 Hz

(B) 330 Hz

(C) 350 Hz

(D) 380 Hz

(E) 490 Hz

32. The refractive index of water is 1.33. A point light source in water can be seen directly above the water as a circular bright disc. At a certain period of time, the light source position is seen to be unchanged but the radius of the bright disc decreases and then increases to its original length. We can thus conclude that

(A) The light source is continuously lowered till a certain depth.

(B) The light source is continuously raised till a certain depth.

(C) The light source is continuously raised and subsequently lowered back to its original depth.

(D) The light source is continuously lowered and subsequently raised back to its original depth.

(E) The light source is dimmed and then brightened.

33. Four identical batteries, each of emf ϵ and internal resistance r, are joined in series to form a closed circuit. One of them, battery A, is joined with reverse polarity to the rest. The potential difference across each battery except A is

(A) $\frac{1}{4}\epsilon$

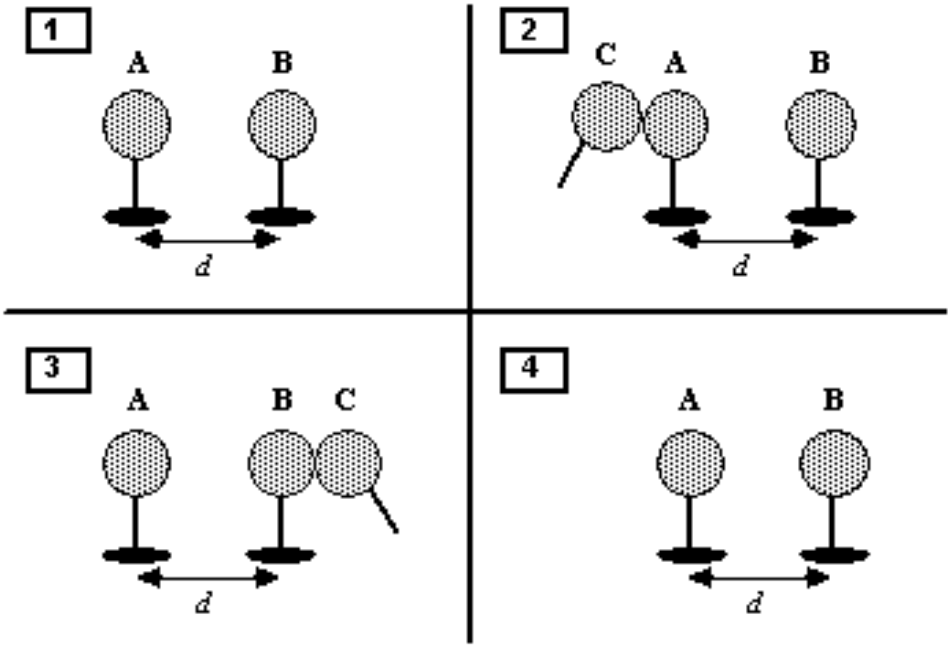
(B) $\frac{1}{2}\epsilon$

(C) $\frac{3}{4}\epsilon$

(D) ϵ

(E) $\frac{3}{2}\epsilon$

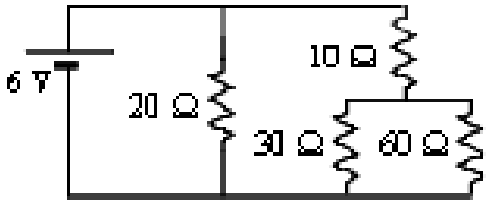
34. Two identical conducting spheres A and B carry equal amounts of excess charge that have the same sign (Frame 1). They are separated by a distance d (which may be assumed to be large compared to the dimension of the spheres). Sphere A exerts an electrostatic force on sphere B that has a magnitude F. Another identical sphere C, on an insulating rod and is uncharged, is touched first to sphere A (Frame 2) and then sphere B (Frame 3) and is finally removed (Frame 4). The magnitude of the electrostatic force that sphere A exerts on sphere B in Frame 4 is approximately



(A) zero.
(B) $3F/8$.
(C) $F/3$.
(D) $F/2$.
(E) $3F/4$.

35. Four resistors and a 6-V battery are arranged as shown in the circuit diagram. Through which resistor(s) does the smallest current in the circuit pass through?

(A) 10 Ω resistor
(B) 20 Ω resistor
(C) 30 Ω resistor
(D) 60 Ω resistor
(E) Same for both 30 Ω and 60 Ω resistors



36. Four large conducting plates, each of area A, are placed an equal distance d apart as shown in the following figure. Given that the permittivity of the medium filling the space between the plates is ϵ, what is the capacitance of this arrangement, assuming that the two terminals a and b of the capacitor are connected to the plates as shown?

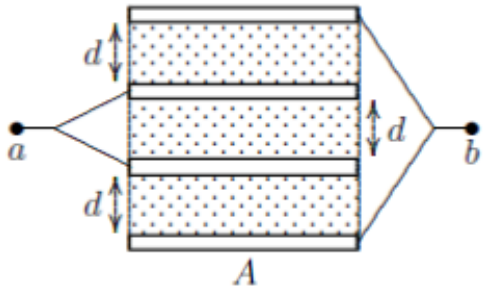
(A) $\frac{\epsilon A}{2d}$

(B) $\frac{\epsilon A}{d}$

(C) $\frac{2\epsilon A}{d}$

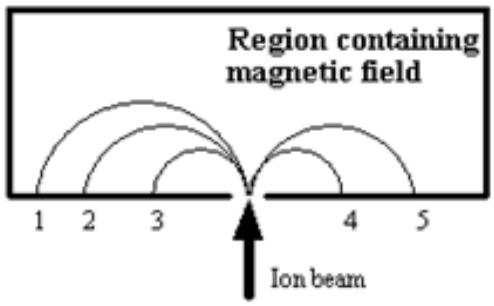
(D) $\frac{3\epsilon A}{d}$

(E) $\frac{4\epsilon A}{d}$



37. A beam consisting of five types of ions labeled A, B, C, D, and E enters a region that contains a uniform magnetic field as shown in the figure. The field is perpendicular to the plane of the paper, but its precise direction is not given. All ions in the beam travel with the same speed. The table below gives the masses and charges of the ions.

Ion	**Mass**	**Charge**
A	$2u$	$+e$
B	$4u$	$+e$
C	$6u$	$+e$
D	$2u$	$-e$
E	$4u$	$-e$



Which ion falls at position 3?

(A) A

(B) B

(C) C

(D) D

(E) E

38. Two point charges which are equal in magnitude but opposite in sign are placed at certain distance apart. By Coulomb's Law, you have learned that they will experience an electric force pointing toward each other. Suppose now we place a neutral insulating rod in between the two charges, as shown in the figure below.

Which of the following statements is correct?

(A) The magnitude of the electric force acting on each charge will become zero.

(B) The force will still be attractive, and the magnitude of the electric force acting on each charge will increase.

(C) The force will still be attractive, and the magnitude of the electric force acting on each charge will decrease.

(D) The force will become repulsive, and the magnitude of the electric force acting on each charge will increase.

(E) The force will become repulsive, and the magnitude of the electric force acting on each charge will decrease.

39. An infinite conducting cylinder of radius R_2, has an infinite concentric cylindrical cavity of radius R_1. The cross section is as shown below. The cylinder has no charge but a thin wire carrying positive charge per unit length ρ runs along the center of the cylindrical hollow, parallel to the cylinder. What is the charge per unit length on the inner surface of the cylinder?

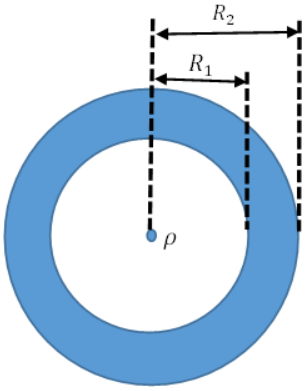
(A) $-\dfrac{\rho}{2\pi R_1}$

(B) $-\dfrac{\rho}{4\pi R_1^2}$

(C) $-\dfrac{\rho}{2\pi R_2}$

(D) $-\dfrac{\rho}{4\pi R_2}$

(E) $\dfrac{\rho}{2\pi R_1}$



40. An electron moves at constant speed in a uniform magnetic field. If the initial velocity of the electron is perpendicular to the magnetic field, the electron describes a path that is a

(A) straight line

(B) helix

(C) circle

(D) parabola

(E) hyperbola

41. An alpha particle and a proton follows the same circular path in a uniform magnetic field. What is the ratio of the alpha particle's velocity to the proton's velocity? You can consider the case to be non-relativistic.

(A) 1/4

(B) 1/2

(C) 1

(D) 2

(E) 4

42. A two-range d.c. voltmeter has a common negative terminal and two positive terminals, one to give a full scale deflection for 10 V and the other to give a full scale deflection of 3 V. The resistance of the voltmeter between the negative terminal and +3 V terminal is 1000 Ω. The resistance between the negative terminal and the +10 V terminal is

(A) 300 Ω

(B) 333 Ω

(C) 1000 Ω

(D) 3000 Ω

(E) 3333 Ω

43. The e.m.f ϵ induced in a coil by the changing magnetic flux is equal to the rate of change of the flux $\epsilon = -d\phi/dt$. Which of the following is a unit for magnetic flux ϕ?

(A) ms^{-1} A

(B) ms^{-2} A^{-1}

(C) kg m^2 s^{-2} A

(D) kg ms^2A^{-1}

(E) kg $\text{m}^2\text{s}^{-2}\text{A}^{-1}$

44. A plastic ring **A** is rubbed with rabbit fur and gains a negative charge. It is then placed inside a metal ring as shown in the diagram below. An electrical current can be induced in the metal ring **B** (anticlockwise as indicated in diagram) when **A** is

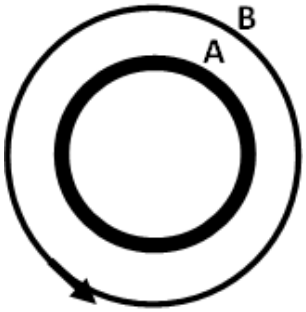
(A) turning clockwise with constant angular velocity.

(B) turning anti-clockwise with constant angular velocity.

(C) turning clockwise with increasing angular velocity.

(D) turning anti-clockwise with increasing angular velocity.

(E) not turning.



45. 3 resistors of the same resistance $R_1 = R_2 = R_3 = R$ forms a triangular circuit as shown. When one of the resistances is changed, measurements show that $R_{AB} = R_{AC}, R_{BC} = R/2$. Which is the resistance that has been changed and what is its new resistance?

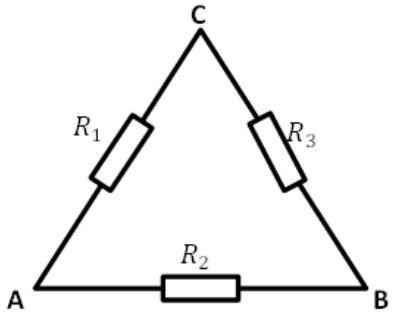
(A) $R_1 = R/3$

(B) $R_2 = R/3$

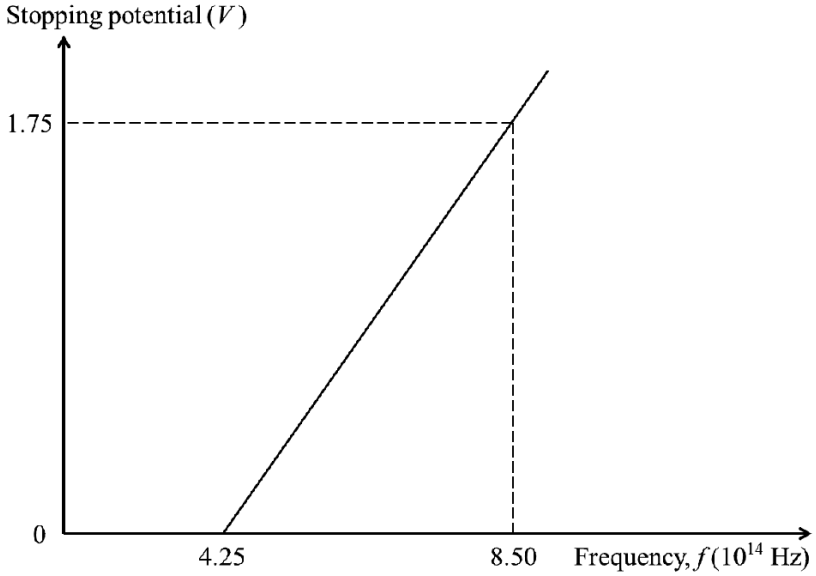
(C) $R_2 = 2R/3$

(D) $R_3 = R/3$

(E) $R_3 = 2R/3$



46. Consider a photoelectric effect experiment. The figure below shows the plot of the stopping potential against the frequency of the incident light falling on a metal surface. What is the work function of the metal?



(A) 1.45 eV
(B) 1.55 eV
(C) 1.65 eV
(D) 1.75 eV
(E) 1.85 eV

47. Which of the listed phenomena can be explained if we assume that light is a particle?

I) A beam of light strikes a mirror and its angle of incidence is measured to be the same as its angle of reflection.
II) When a beam of light passes through a small circular aperture and onto a screen, the size of the spot of light on the screen increases as the aperture size decreases.
III) A beam of laser light passing through 2 closely spaced slits produces a series of bright and dark fringes on a screen.
IV) Electrons are ejected from a metal surface only when it is illuminated by light with frequency above a certain value.

(A) I and IV only
(B) I, II and III only
(C) IV only
(D) II and III only
(E) All of the above

48. Which of the following lists contains a device that does NOT make use of the quantum nature of the universe?

(A) cell phone, credit card with a chip, car keyless entry

(B) calculator, DVD player, laser light show

(C) laptop computer, digital clock, grocery checkout scanner

(D) iPod, Internet, LED light

(E) None of the above

49. A deuteron is incident on a lead nucleus at Brookhaven National Laboratory. The terminal voltage of the accelerator is 15 MV. Find the distance of closest approach in a head-on collision.

(A) 7.87 fm

(B) 15.74 fm

(C) 5.32 fm

(D) 10.64 fm

(E) 13.20 fm

50. 2015 is the International Year of Light as declared by the United Nations. 100 years ago, the theory of General Relativity developed by Einstein showed how light was at the center of the very structure of space and time. Which of the following is NOT a true statement about the general theory of relativity?

(A) True physical laws hold only in an inertial coordinate frame.

(B) The gravitational equations can be applied to any coordinate system.

(C) The gravitational equations are structure laws describing the changes of the gravitational field.

(D) The universe is not Euclidean.

(E) The ellipse of the planet Mercury rotates with respect to the sun.

END OF PAPER.