

M.Prakash Academy
Entrance Test Paper
(2012 to 2016)
for
STD : XI

M. Prakash Academy

April 10, 2016

1.00 pm to 5.00 pm

Total marks: 200

Section - Chemistry:**Useful data:****Atomic numbers:**

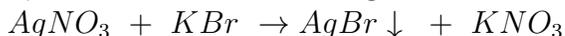
H:1; C:6; N:7; O:8; Na:11; Mg:12; Al:13; P:15; S:16; Cl:17; K:19;
Ca:20; Fe:26; Zn:30; Br:35; Ag:47; Ba:56.

Atomic masses:

H:1; C:12; N:14; O:16; Na:23; Mg:24; Al:27; P:31; S:32; Cl: 35.5;
K:39; Ca:40; Fe:56; Zn:65; Br:80; Ag:108; Ba:137.

Q1. When iron is strongly heated with steam, a mixed oxide 'A' of iron is obtained. Hydrogen gas is evolved as a by product. If molar mass of compound 'A' is 'M', find the value of $\frac{M}{4}$.

Q2. Consider the following reaction:



Calculate the amount of precipitate in gm obtained when 0.25 mole of $AgNO_3$ is treated with excess of aqueous KBr solution.

Q3. An element exists in 2 isotopic forms 'A' and 'B'. It's average atomic mass 35.5 amu. Write the difference of neutrons between 'A' and 'B'.

Q4. A sample of gas 'A' at 300 K has initial volume of V_1 and 0.2 atm pressure. It's final volume at 15 atm pressure and 300 K temperature is V_2 . If $V_1 = V_2 \times X$, find X .

Q5. Two moles of a hydrocarbon C_nH_{2n} burns in 'M' moles of O_2 to produce 10 moles of H_2O as one of the products. Find 'M'.

Q6. IUPAC name of an organic compound is 3-Methylpent-1,3-diene. Compute the structure of this compound and find the number of Hydrogen atoms attached only to the saturated carbon atoms in it.

Q7. When sodium salt of carboxylic acid 'A' is heated with sodalime ($NaOH + CaO$) gas 'B' is produced. Gas 'B' is also called Marsh Gas. Write the molecular weight of the carboxylic acid used to produce the above sodium salt.

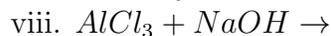
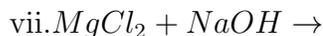
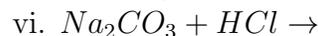
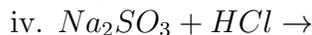
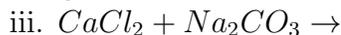
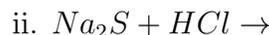
Q8. While converting 1 mole of Bauxite into Aluminium, 60.87

percent weight loss is observed. Calculate the loss in weight(in gm) when 69 gm of Bauxite is converted into Aluminium. Enter the integer part of your answer in the bubble sheet.

Q9. The oxide of a sublimative element 'A' is treated with water to form a tribasic acid 'B'. 'A' exists as 'A₄' in nature . 'B' contains only one atom of element 'A'. Identify 'B' .Write the molar mass of 'B'.

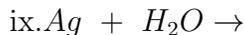
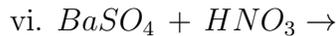
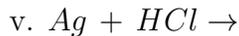
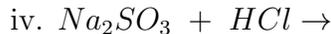
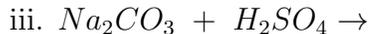
Q10. One mole of a light green compound of Iron is dehydrated. On strong heating it forms two gaseous products 'A' and 'B' along with an oxide of higher valency of Iron. 'A' and 'B' are oxides of the same element. Write the sum of the amount of the gaseous products obtained in gm.

Q11. Identify the total number of reactions from the following in which NaCl is obtained as one of the products.



Q12. Bicarbonate of an element 'A' is responsible for the temporary hardness of water. When 'A' is burnt in air, two compounds 'B' and 'C' are obtained. 'C' gives a pungent smelling gas 'D' on reacting with water. 'D' turns moist red litmus to blue. Identify 'D' and write its molar mass .

Q13. How many of the following reactions will produce a gaseous product?

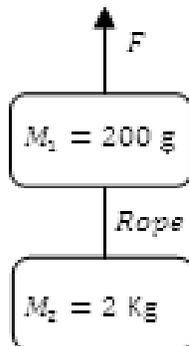


Section - Physics:

Important: Take value of 'g' as 10 m/s^2 wherever required.

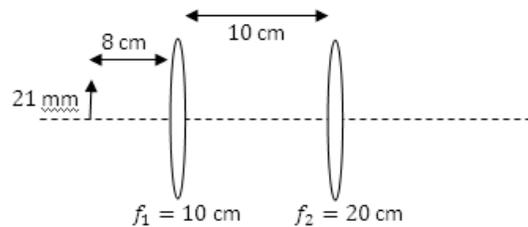
Q14. Two particles left point A simultaneously at $t = 0$ and reached point B simultaneously at $t = 2$ hours. The first particle traveled half the distance at speed $v_1 = 30 \text{ km/h}$ and the other half at $v_2 = 45 \text{ km/h}$. The second particle traveled the entire distance with constant acceleration, starting from rest. Let t_1 and t_2 be the moments of time at which the speed of both the particles is same. Write as your answer, the larger of the two values. Express your answer in minute.

Q15. Two blocks of masses $M_1 = 200 \text{ g}$ and $M_2 = 2 \text{ kg}$ are connected by a light inextensible rope. The maximum tension that the rope can bear without breaking is 80 N . What is the maximum value of force F with which block M_1 should be pulled up so that the rope does not break? Express your answer in Newton.

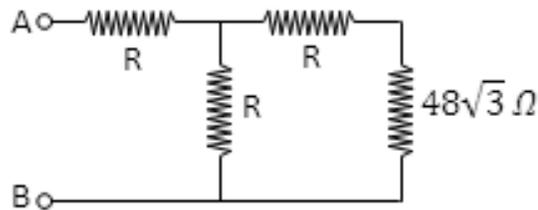


Q16. Two flat metal plates, mounted vertically and parallel to each other are made to move toward each other with a constant speed of 5 m/s with respect to ground. A particle that can bounce back between the two plates starts from one plate when the plates are 20 m apart. When reaching the second plate, it bounces back and so on. If the particle keeps on traveling at constant speed of 25 m/s , determine the total distance it can travel before the plates collide? Express your answer in meter.

Q17. Two convex lenses of focal lengths $f_1 = 10$ cm and $f_2 = 20$ cm are placed parallel to each other at separation $d = 10$ cm with common principle axis. An object of height $h = 21$ mm is placed in front of the first lens at distance $u = 8$ cm as shown. The image formed in this lens acts as an object for the second lens. Determine the height of the image that forms in the second lens. Express your answer in mm.

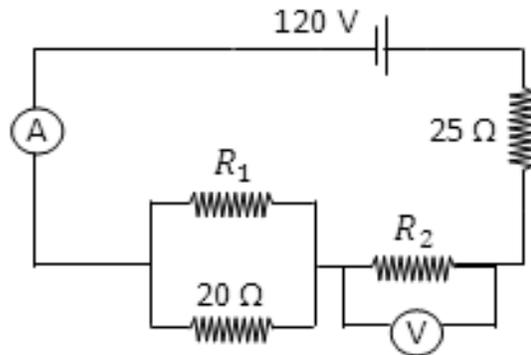


Q18. In the electric circuit shown, there are two kinds of resistors: an unknown resistance R and a known resistance of value $48\sqrt{3}$ Ω . What should be the value of resistance R , so that the equivalent resistance between points A and B is $48\sqrt{3}$ Ω ?



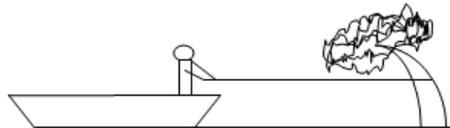
Q19. Two towns A and B are connected by a regular bus service with a bus leaving in either direction every T minutes and moving with the same constant speed. A man cycling with a speed of 20 km/h, in the direction from A to B, notices that a bus goes past him every 18 minutes in the direction of motion and every 6 minutes in the opposite direction. Determine T in minutes.

Q20. In the circuit shown, voltmeter and ammeter are considered ideal instruments. This means that the resistance of the ammeter is zero, while that of the voltmeter is infinite. The ammeter reads 2 A and the voltmeter reads 40 V. Determine the value of resistance R_1 .



Q21. A rain drop of mass 10 g falls from height 500 m above the ground. It falls with decreasing acceleration (due to viscous force of air) until at half its original height it attains maximum speed of 10 m/s. For the remaining journey it falls with this constant speed. Determine the total heat energy generated (to the nearest integer) during the first half of its fall. Express your answer in Joule.

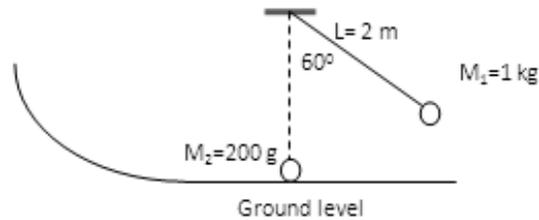
Q22. A man is sitting in a boat. The total mass of man and boat is 400 kg. He begins to pull on a horizontal rope tied to a tree on the bank. The man pulls with force of 100 N as a result of which the boat begins to move on water. What is the power developed by the man at the end of the third second from the beginning of motion? Express your answer in watt. Neglect mass of the rope and resistance of water.



Q23. An opaque disc of diameter 66 mm is floating on a liquid of refractive index $\sqrt{5}$. The liquid is filled in a wide vessel to a depth of 3.3 cm. A point source of light is held in air above the center of the disc at height 3.3 cm above it. Determine the diameter of the shadow formed on the bottom of the vessel. Express your answer in mm.

Q24. An object is thrown upwards from ground with some velocity. Assume that air friction acts on the body such that the force of friction is always one-fifths the weight of the body. Let T_1 be the time of ascent and T_2 be the time of descent of the body. Let $N = 30 \times \left(\frac{T_1}{T_2}\right)^2$. Write the value of N in the bubble sheet. [Note that the force of air friction is always opposite to the direction of motion. So during ascent, the friction force on the body is acting downwards, while during descent, it is acting upwards].

Q25. Mass $M_1 = 1$ kg is suspended from a light string to form a simple pendulum. Length of the string is $L = 2$ m. It is taken aside through 60° is released. At the lowest point, M_1 collides with a stationary mass $M_2 = 200$ g. After collision M_1 stops and M_2 begins to move with some speed on a smooth surface. The surface gradually curves upwards and becomes vertical. Calculate the height to which M_2 will ultimately rise above the ground level. Express your answer in meter. Neglect air resistance.



Q26. Consider a uniform spherical planet of density ρ . Acceleration due to gravity at the surface of the planet is 6.7 m/s^2 and the radius of the planet is 4200 km. Calculate density ρ of the planet in the units $[\text{g/cc}]$. Express your answer to the nearest integer. Useful formula: volume of a sphere of radius R is $V = \frac{4\pi R^3}{3}$. Take $G = 6.7 \times 10^{-11}$ $[\text{Nm}^2/\text{kg}^2]$. and take $\pi = 22/7$.

Section - Maths:

Q27. Segment AC is a diameter of a circle S . Segment BA touches S at A . $AB = 2AC$. Segment BC intersects circle S at D . $AD = 8$. Find the area of the square inscribed in circle S .

Q28. In isosceles trapezium $\square ABCD$, $\overline{AB} \parallel \overline{CD}$. Circle with \overline{BC} and \overline{AD} as diameters touch each other at E . If $2BE = AD$, $BC = 10$ and area of $\square ABCD = P$ then find $\frac{P}{\sqrt{3}}$.

Q29. In $\triangle ABC$, $AB = 34$, $AC = 50$, median $BE = 39$. Find the length of altitude AD .

Q30. In $\triangle ABC$, $A = (0, 10)$, $B = (6, 8)$, $C = (-6, -8)$. \overline{AD} is internal angle bisector and \overline{AE} is external angle bisector, with D and E on line BC . Find area of $\triangle ADE$.

Q31. Let $a_1, a_2, a_3, \dots, a_{15}$ be in an A.P.

$$a_1 + a_2 + \dots + a_{10} = A$$

$$a_6 + a_7 + \dots + a_{15} = B$$

If $B - A = 200$ and $B + A = 860$, then find a_{15} .

Q32. Let x is a real number satisfying

$$x^2 + x + \frac{1}{x} + \frac{1}{x^2} = 54 \quad , \quad x^3 + x + \frac{1}{x} + \frac{1}{x^3} = 329 \quad \text{and} \quad x^2 - mx + 1 = 0.$$

Find value of m^2 .

Q33. K is a positive real number such that $x^3 - 2x^2 + 2x - 15 = 0$ and $x^3 + (K - 8)x^2 - 7x - (K + 30) = 0$ have one real root common. Find K .

Q34. If $9x^3 - 6x^2y + y^3 = (ax + by + c)(dx^2 + exy + fy^2)$ where a, b, c, d, e, f are integers.

Find the value of $a^2 + b^2 + c^2 + d^2 + e^2 + f^2$.

Q35. If $4 \sin^2 A - 13 \sin A + 3 = 0$. Find value of $32 \cos^2 A + \cot^2 A$.

Q36. Let $S = \{1, 2, 3, \dots, 134, 135\}$. Find the number of elements in S which are divisible by at least one of 2, 3, 5.

Q37. If $A_1 = (x_1, y_1)$ and $A_2 = (x_2, y_2)$ are solutions of $4xy - 11y - 17x + 43 = 0$ and $6xy - 21y - 3x + 33 = 0$ then find the value of $x_1 + y_1 + x_2 + y_2$.

Q38. Note that \sqrt{k} means non negative square root of a non negative real number k . For example: $\sqrt{25} = 5$ and not -5 .

Let x be a real number such that

$$\sqrt{-x-1} + \sqrt{6-x} - \sqrt{14-x} = 0 \quad \text{then find the value of } |15x|.$$

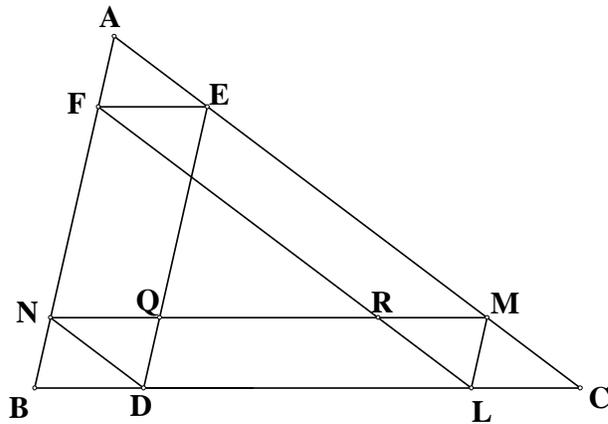
Q39. Circles with centers M, N touch each other externally at point P and also touch a line at A and B respectively. Common tangents to these circles at P intersects segment AB at T . $MA = 27$ and area of quadrilateral $AMPT = 486$. Find NB .

Q40. As shown in figure, in $\triangle ABC$ a point D is chosen on \overline{BC} such that $4BD = DC$. Note that

(i) $\overline{AB} \parallel \overline{ED} \parallel \overline{ML}$ (ii) $\overline{BC} \parallel \overline{NM} \parallel \overline{FE}$ (iii) $\overline{AC} \parallel \overline{FL} \parallel \overline{ND}$.

\overline{MN} intersects \overline{ED} and \overline{FL} at Q and R respectively. Area of quadrilateral $QDLR$ is 13.

Find the area of $\triangle ABC$.



M. Prakash Academy Entrance Examination 2015

Time: 1.00 pm to 5.00 pm

Total marks: 200

Chemistry

Atomic weights of some elements are given below:

$C = 12$, $O = 16$, $Na = 23$, $Mg = 24$, $Al = 27$, $Cl = 35.5$, $S = 32$
 $Fe = 56$, $Cu = 64$, $Zn = 65$, $Br = 80$, $H = 1$, $K = 39$, $I = 127$, $Ca = 40$

Avogadro's number = 6.023×10^{23} per mole.

1. In an experiment concentrated brine (sodium chloride solution in water) is made to undergo electrolysis and a gas A is collected at the anode. In another experiment acidulated water is made to undergo electrolysis and gas B is collected at the cathode. A and B are made to react in the presence of sunlight to give C . In a third experiment ten molecules of aluminium hydroxide react with C to give a salt. How many molecules of C are used up?

2. How many of the following list would react with hydrochloric acid on heating and produce a gaseous substance? The gaseous substance must remain a gas even after cooling to 60°C . Count number of such substances from the following list and enter that number in your bubble sheet.

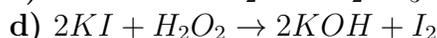
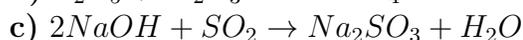
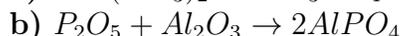
Al , Cu , MgO , Na_2O , KOH , Ag , MnO_2 , PbO_2 , $KMnO_4$, $NaHCO_3$.

3. MCl_2 and $M'Cl_2$ are two metal chlorides. Both are soluble in water. MCl_2 is found in sea water. MCl_2 is responsible for making table salt deliquescent. Both, MCl_2 and $M'Cl_2$, are responsible for imparting hardness in water. If the metal M is in period number x of the periodic table and M' is in period number y of the periodic table, then what is the numerical value of $x + y$?

4. A strip of burning magnesium ribbon is dropped into a gas jar containing gas X . X is colourless and odourless. X turns lime water milky. The strip of magnesium ribbon continues to burn in X , and a substance Y is produced. Y is a solid and sticks to the sides of the gas jar. Y is collected and heated strongly with haematite, as a result another element Z is produced. 20 atoms of Z react with chlorine to produce a volatile salt. How many electrons are

transferred from 20 atoms of Z to chlorine during the course of the reaction? The oxidation state of the element Z in the volatile salt is the same as its oxidation state in the mineral haematite.

5. From the following four examples, choose the example showing redox reaction. From this reaction, determine the molecular weight of the substance undergoing reduction.



6. In how many of the following examples is the pH more than 7? Enter the total number of those examples in your bubble sheets.

a) One ml of HCl is added to 10 litres of water.

b) One ml of $NaOH$ in aqueous solution form is added to 10 litres of water.

c) 12 g of $NaHCO_3$ is dissolved in water to make a one litre solution.

d) Ammonia gas escapes from a factory and it dissolves in the falling rain. This rain water is collected in a basin.

e) 24 g of $NaCl$ is dissolved in water to make a 3 litre solution.

7. The purest allotrope of carbon has x membered carbon rings and y membered carbon rings. What is the value of $x + y$?

8. A certain amount of gas at $27^\circ C$ and at a pressure of 1.8 atmosphere is contained in a glass vessel. Suppose that the vessel can withstand a pressure of 2.1 atmosphere. How high can you raise the temperature of the gas without bursting the vessel? Write the answer in degree centigrade.

9. What weight (in gram) of $NaOH$ that will have the same number of molecules as 100 g of SO_3 ?

10. 720 g of aluminium metal of 25% purity is made to react with excess of $NaOH$ in aqueous solution form. How many moles of hydrogen gas will be formed?

11. A sample of magnesium carbonate containing some inert impurity is heated strongly. The weight of the impure sample taken initially (before heating), is 210 g. After heating 10 g of magnesium oxide was produced. What is the percentage purity of the sample of magnesium carbonate?

12. Sodium carbonate reacts with sulphuric acid in the following manner



0.6 moles of sodium bicarbonate reacts fully with sulphuric acid solution. Sulphuric acid solution has 3 moles of sulphuric acid in 900 ml solution. What volume of sulphuric acid solution is needed to fully react with the 0.6 moles of sodium bicarbonate?

13. The second member of the homologous series of alkenes is made to undergo hydrogenation. What is the molecular weight of the product after hydrogenation?

Physics

Take $g = 10 \text{ m/s}^2$ and density of water = 1 g/cc .

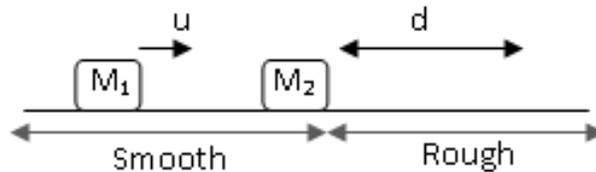
Q14. The relationship between the displacement S of a body and time t is given by the equation: $S = A - Bt + Ct^2$. S is expressed in meter and t in seconds. Numerical values of the constants are $A = 6$, $B = 3$ and $C = 1$ with appropriate SI units. Mass of the body is 4 kg. If the motion begins at $t = 0$, calculate the power delivered to the body at $t = 4$ seconds. Express your answer in watt.

Q15. A body of mass 2 kg is at rest on a smooth horizontal surface. A constant horizontal force F begins to act on the body. It is observed that the body acquires velocity of 6 m/s after travelling the distance of 2 m. Calculate F . Express your answer in Newton.

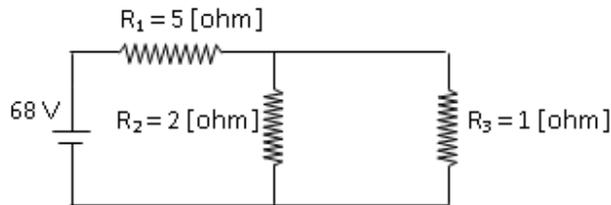
Q16. A boy is throwing balls vertically into air. Time interval between the two consecutive throws is constant. He throws a ball whenever the previous one is at its highest point. All balls are thrown from the same point and with the same initial velocity. If he throws two balls per second, calculate how high a ball rises above its initial position. If this height H is expressed in centimeter, write the value of $(H/5)$ in your answer book.

Q17. A block of mass $M_2 = 2 \text{ kg}$ is at rest on a horizontal surface. The portion of the surface to the left of the block is smooth, while the one to the right is rough. Another block of mass $M_1 = 1 \text{ kg}$, moving with speed $u = 4 \text{ m/s}$ collides with M_2 as shown. After the collision, M_1 stops and M_2 begins to move towards right. After travelling a distance of $d = 20 \text{ cm}$, M_2 stops. Calculate the value

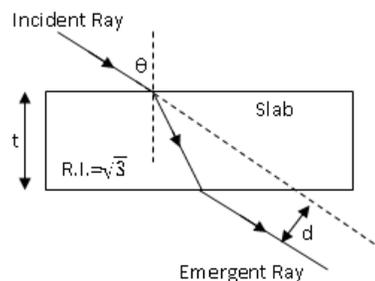
of the frictional force exerted by the rough surface on M_2 . Express your answer in Newton.



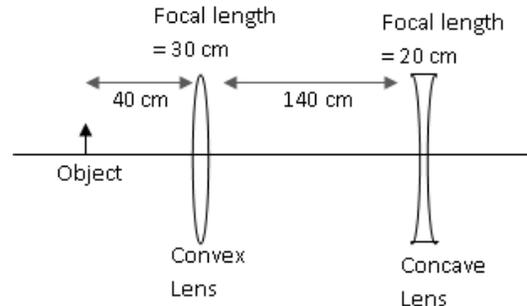
Q18. In the circuit shown, calculate the power dissipated in resistor R_2 . Express your answer in watt.



Q19. Consider a ray of light falling at angle incidence $\theta = 60^\circ$ on a transparent slab of thickness $t = 17\sqrt{3}$ cm. The slab is placed in air and refractive index of the material of the slab is $\sqrt{3}$. The ray travels through the slab as shown and emerges on the other side. The emergent ray is parallel to the incident ray, only shifted by a certain distance d . Calculate d . Express your answer in centimeter.

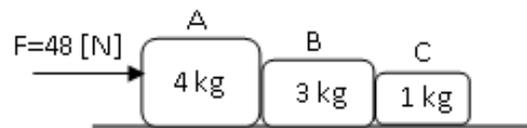


Q20. A convex lens of focal length 30 cm and a concave lens of focal length 20 cm are placed along a common principle axis at separation of 140 cm. A small object is placed at distance 40 cm from the convex lens, as shown. The convex lens creates an image of this object. This image acts as an object for the concave lens and a second image is created due to refraction in the concave lens. Determine the distance of this second image from the concave lens.



Q21. Consider a hemispherical bowl of mass 236 gram and capacity 300 cm^3 . The wall of the bowl is assumed to be very thin. The bowl is floating in water. What is the maximum volume of oil (of density 0.8 g/cc) that can be poured in the bowl so that it is prevented from sinking in the water? Express your answer in cm^3 .

Q22. Three blocks A , B and C are placed on a smooth horizontal surface. A constant horizontal force $F = 48 \text{ N}$ is applied on block A as shown. Determine the value of force applied by block B on block A . Express your answer in Newton.



Q23. An elevator of mass 700 kg is moving upwards with speed 3 m/s and decelerating at the rate 2 m/s^2 . Determine the tension in the supporting cable. If the tension is written as $T = \alpha \times 10^2 \text{ N}$, calculate α and write it in your answer book.

Q24. An astronaut (with his space suite) weighs 120 kg on earth. What would he weigh on Mars? Mass of mars is one-tenth that of earth and radius is half that of the earth. Express your answer in Kg . Note: Weight is measured in Newton, but we usually express it in Kg , since weight is proportional to the mass.

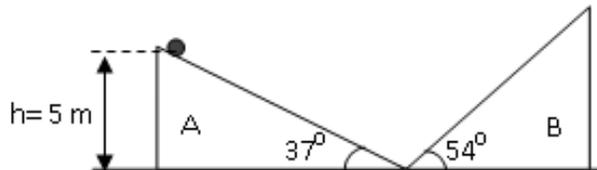
Q25. An alternating voltage is generated by a closed loop of conducting wire frame rotating in magnetic field. The value of alternating voltage generated is given by the formula:

$$V = 2\pi f N A B \sin(2\pi ft).$$

Here V : voltage [Volt], f : frequency of alternating voltage [Hertz],
 N : number of turns of the wire frame, A : area of the wire frame

$[m^2]$, B : magnetic field generated by permanent magnets [Tesla],
 t : time [second].

Consider a wire frame of area $\frac{100}{\pi} \text{ cm}^2$, number of turns 100, rotating with frequency 50 Hz in a constant magnetic field of 0.1 Tesla . If the frame starts at $t = 0$, calculate the instantaneous value of the voltage generated $(1/40)$ seconds after the start of motion. Express your answer in Volt. **Q26.** Consider two smooth inclined planes A and B joined to each other at the base as shown. A particle is released on the incline plane A , from the height of $h = 5 \text{ m}$. It slides down the incline, reaches the base and smoothly climbs up inclined plane B . It now slides down the plane B and again climbs up inclined plane A . It keeps on moving up and down the two planes A and B . The particle undergoes oscillatory motion. Let T be the time period of one complete oscillation, expressed in seconds. Find $5T$. Take $\sin 37^\circ = 0.6$ and $\sin 54^\circ = 0.8$.



Mathematics

Q27. In $\triangle ABC$, M is the midpoint of segment BC .
 $AB = 17$, $AC = 25$ and $AM = \sqrt{261}$. Find $32 \tan B$.

Q28. $A_1A_2A_3\dots\dots A_{12}$ is a regular polygon whose area is 432.
 Find $(\sqrt{6} + \sqrt{2})A_1A_2$.

Q29. In $\triangle ABC$, internal and external bisectors of angle A meet line BC in D and E respectively. $DB = 6$, $DA = 9\sqrt{2}$ and $DC = 9$.
 Find $(AE^2 - 1100)$.

Q30. S_1 is a circle with center M_1 and radius 55. S_2 is a circle with center M_2 and radius 30. Direct common tangent of S_1 and S_2 touches S_1 at A_1 and S_2 at A_2 . Area of quadrilateral $M_1A_1A_2M_2 = 2550$. Find M_1M_2 .

Q31. Point P is in the plane of circle S with center M and radius 38. $PM = 83$. Tangents from P to S touch S at A and B . Let I be the incenter of $\triangle PAB$. Find IM .

Q32. A semicircle S is drawn on segment AB as a diameter. D is a point on S . C is the foot of perpendicular from D on diameter AB . A circle K is such that its center is on segment CD , touches segment AB at C and touches semicircle S at E . $AB = 6, CD = \sqrt{6}$. If R is the radius of K then find $(48R)$.

Q33. In $\triangle ABC$, D is the foot of the altitude from A on segment BC . E is the midpoint of segment AC . I is the incenter of $\triangle ABC$. If $AB = 11, DE = 6$ and $\angle BIC = 105^\circ$, find the area of $\triangle ABC$.

Q34. $0 < A < 90$. If $40 \sec A + 29 \cos A = 78$ then find $28(\tan A + \sec A)$.

Q35. $\triangle ABC$ is drawn in the XY plane. Let G be the centroid of $\triangle ABC$. Let M be the circumcenter of $\triangle ABC$. If $A \equiv (2, 10), B \equiv (2, 4)$ and $G \equiv (4, 6), M \equiv (X_M, Y_M)$ then find $(4X_M + 6Y_M)$.

Q36. Let a_1 and a_2 be the values of a for which the roots of the equation $x^2 + ax + a + 2 = 0$ are in the ratio $1 : 2$. Find $6(a_1 + a_2)$.

Q37. x and y are positive real numbers such that $\sqrt{x^2 + \sqrt[3]{x^4 y^2}} + \sqrt{y^2 + \sqrt[3]{x^2 y^4}} = 512$. Find $x^{\frac{2}{3}} + y^{\frac{2}{3}}$.

Q38. x is a real variable. If x_1 and x_2 are the solution of $\sqrt{x+3} - 1 = \sqrt{x - \sqrt{x-2}}$ then find $9(x_1 + x_2)$.

Q39. Find 20 times the sum of the squares of the roots of the equation

$$4^{x+\sqrt{x^2-2}} - 5 \times 2^{(x-1)+\sqrt{x^2-2}} = 6.$$

Q40. A person has unlimited supply of Rs.10, Rs.5 and Rs.1 notes. Find the number of ways in which he can pay Rs.80 using these notes only.

M. Prakash Academy Entrance Exam 2014

Time: 1.00 pm to 5.00 pm

Total marks: 200

Physics

Note:

1. Wherever required, take value of acceleration due to gravity $g = 10 \text{ m/s}^2$, density of water = 1 gm/cc .
2. Be careful about units. Express your answers in the units mentioned in respective problems.

Q1. Square of the average speed of molecules of a gas can be given by the following formula: $v^2 = \frac{3RT}{M}$. R is called universal gas constant and has value $R = 8.4 \frac{\text{Joule}}{\text{Mole.Kelvin}}$, T is temperature expressed in Kelvin and M is the molecular weight of the gas expressed in $\frac{\text{Gram}}{\text{Mole}}$. Consider a gas at temperature of 27°C and having molecular weight of 25. For this gas v^2 is expressed as $k \times 10^n [\frac{\text{m}}{\text{s}}]^2$. If k is a number between 1 to 5, then the value of n is \dots .

Q2. A stone is dropped from the top of a tall building. Two second later another stone is dropped from the same point. Let D be the distance between the stones, 1.5 second after the 2nd stone is dropped. Then the value of D in meter is \dots . Ignore air resistance.

Q3. The speed of a motor boat with respect to water is $v = 7 \text{ m/s}$. The speed of water with respect to the banks is 3 m/s . When the boat began travelling upstream, a buoy was dropped from it. A buoy is a body that can float in water. The boat travelled 4.2 km upstream (with respect to banks), turned about and caught up with the buoy. Let T be the time between dropping the buoy and catching up with it again. Let it be expressed in second as $T = m \times 10^2$ then the value of m is \dots .

Q4. A person performs the following experiment to measure the acceleration of an elevator (i.e. a lift). She takes a weighing machine, keeps it on the floor of the elevator. She records her mass as 50 kg when the elevator is at rest. She continues to stand on the machine and then starts the elevator, which begins to move down. She records her mass to be 48 kg during the downward acceleration of the elevator. From this observation, she calculates acceleration of the elevator and expresses as $a \frac{\text{cm}}{\text{s}^2}$. Then the value of a is \dots .

Q5. A copper ball of mass 1 kg is dropped from a height of 280 m . It falls to the ground and comes to rest. Assume that all the lost mechanical energy is absorbed by the ball. Due to absorption of heat, temperature of the ball rises.

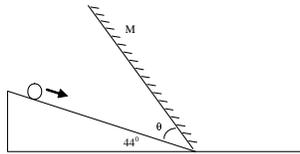
The rise in temperature of the ball, expressed in Celsius, is \dots .

Given: Specific heat capacity of copper is $400 \frac{\text{J}}{\text{kg}^\circ\text{C}}$.

Q6. Two clay balls are moving towards each other along a common straight line. The one on the left has mass 2 kg and velocity 2 m/s . The one on the right has mass 1 kg and velocity 7 m/s . The balls collide and form a single ball of mass 3 kg and keep moving. Some kinetic energy is lost as heat in this process. The lost energy in the process is \dots . Express answer in Joule.

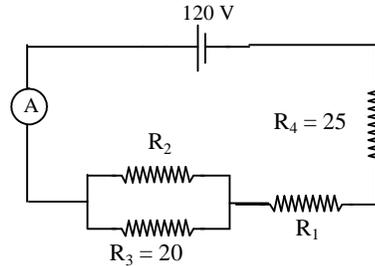
Q7. A metal ball has a single cavity inside it. The ball weighs 264 g in air and 221 g when completely immersed in water. Density of the metal is 8.8 gm/cc . The volume of the cavity inside the ball is \dots . Express your answer in cc.

Q8. A ball is set rolling down an inclined plane of angle 44° as shown. A mirror M is to be placed at the lower edge of the incline such that the image of the ball is seen to be moving downward in exactly vertical direction. Then the angle θ which is made between the incline and the mirror is \dots . Express your answer in degree.

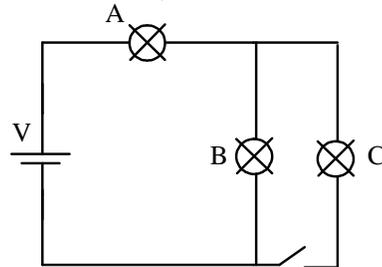


Q9. An object and a screen are placed some fixed distance apart. When a converging lens (convex lens) is placed between the object and the screen, the image formed has twice the size as that of the object. Keeping the object and the screen fixed, the lens is now moved 36 cm closer to the screen than its earlier position. Now the new image size is half the size of the object. The focal length of the lens is \dots . Express your answer in cm .

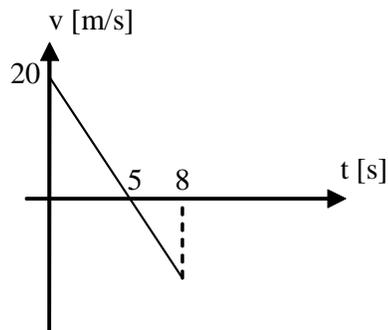
Q10. In the circuit shown, A represents an ammeter and has zero resistance. The battery supplies a potential difference of 120 Volt . It is known that the ammeter shows a current of 2 A and potential difference across resistor R_1 is 40 V . If $R_3 = 20\text{ Ohm}$ and $R_4 = 25\text{ Ohm}$ then the value of resistance R_2 is \dots . Express your answer in Ohm.



Q11. Three identical bulbs are connected, as shown, across a battery. The key K is initially open. Bulb A glows and emits power equal to 27 Watt . The key K is now closed. Then the power emitted by bulb A is \dots . Express your answer in Watt.



Q12. A particle moves along a straight line. Variation of its velocity with time is shown in the graph. The distance travelled by the particle in the time interval $(0, 8)$ second is \dots . Express your answer in meter.



Q13. Assume the earth to be a uniform planet with acceleration due to gravity equal to 10 m/s^2 at its surface. An extra-solar planet is discovered. Its radius is three times the earth's radius. Note that its density (assumed uniform) is 1.1 times earth's density. Then the value of acceleration due to gravity on its surface is \dots . Express your answer in m/s^2 .

Chemistry

Atomic weights of some elements are given below:

$H = 1, C = 12, F = 19, N = 14, O = 16, Na = 23, Mg = 24, Al = 27,$

$P = 31, Cl = 35.5, S = 32, K = 39, Ca = 40, Fe = 56, Cu = 64,$

$Zn = 65, Br = 80, Ag = 108, Ba = 137, Pb = 207$

Avogadro's number = 6.022×10^{23} ,

Volume of one mole of gas at STP = 22.4 lit

Q14. 4.90 gm of $KClO_3$ is heated. It shows a weight loss of 0.384 gm. Percent of the original $KClO_3$ which has decomposed equals ...

Q15. A is a silvery white metal. An alloy of A contains 95% A , 4% Copper, 1% Magnesium and Manganese. This alloy is used in bodies of buses, air craft and kitchen ware. Carbonate of A reacts with Hydrochloric acid to form compound B along with other by-products. The molecular weight of B is 133.5. Oxide of A reacts with caustic soda to form C . The compound C is soluble in water. If K is the molecular weight of C then the value of K is ...

Q16. Acetic acid undergoes a series of substitution reactions with Chlorine. 60 gm of acetic acid completely reacts with Chlorine to get T gm of the final principal product. Then $(T - 100.5)$ equals ...

Q17. As per the law of constant proportion, 5 gm of Hydrogen is associated with P gm of Carbon in Butane. Then P equals ...

Q18. Oxidation number is the effective charge on an atom in free state or combined state. Each oxygen atom in the carbonate and the phosphate radical has -2 oxidation number. Considering the overall charge on the respective radicals, let the oxidation number of Phosphorous be P and the oxidation number of Carbon be C , then $(P - C)$ equals ...

Q19. Lawrencium is the last element in the actinide series of the periodic table. It's atomic number is 103. Actinium is placed in the 3^{rd} group and 7^{th} period of the periodic table.

Then the atomic number of the element which is placed in the 2^{nd} group and 7^{th} period of the periodic table equals ...

Q20. Bromine adds to an alkene with 3 carbon atoms. The molec-

ular weight of the product is R . Then $(R - 150)$ equals \dots .

Q21. There are two solutions of sulphuric acid with concentrations 90% and 10%. S gram of the 90 percent solution is added to to 5 gm of a 10 percent solution. The resultant is a 70 percent solution of sulphuric acid. Then S equals \dots .

Q22. 2.5 gm of a mixture of BaO and CaO is treated with sulphuric acid. 4.713 gm of the mixed sulphate is obtained. Then the percentage of BaO present in the mixture equals \dots .

Q23. One Kg of bauxite ore is taken in a tank and leached with caustic soda. The solution is filtered to remove any iron ore which is in the gangue. The ore is 6.9% pure. Then the weight of caustic soda used is \dots . Express your answer in gram.

Q24. Formaldehyde belongs to a homologous series. The molecular weight of the third member of this series equals \dots .

Q25. LPG stands for Liquefied Petroleum Gas. Varieties of LPG are marketed including a mixture of propane 40% and butane 60%. 10 lit of this mixture is completely burnt to form water and carbon-dioxide. Volume of CO_2 equals \dots . Express your answer in liter.

Q26. An element M belongs to third period and VII-A group and exist as M_2 in atmosphere. It combines with hydrogen to form compound HM , which combines with baking soda for evolving a colourless odourless gas which is used to extinguish fire and wet blue litmus turns to red. HM also turns blue litmus to red. When two moles of HM is treated with one mole of compound $CaXO_3$, one mole of colourless pungent smelling gaseous compound $XO_2(g)$ is evolved which bleaches blue litmus paper. A compound of element X is strong acidic. Weight (in gram) of $XO_2(g)$ gas that is produced when 1.5 moles of $CaXO_3$ is treated with HM equal \dots .

Mathematics

Q27. $\triangle AB_1C_1$ and $\triangle AB_2C_2$ are not congruent. If $AB_1 = AB_2 = 8$, $AC_1 = AC_2 = 6$ and area of $\triangle AB_1C_1 =$ area of $\triangle AB_2C_2 = 12\sqrt{3}$, then $|(B_1C_1)^2 - (B_2C_2)^2|$ equals \dots .

Q28. $\triangle ABC$ is drawn in the XY -plane.

D lies on \overline{BC} such that $BD : DC = 3 : 2$.

E lies on \overline{CA} such that $CE : EA = 3 : 2$.

F lies on \overline{AB} such that $AF : FB = 3 : 2$.

Let $D \equiv (34, 25)$, $E \equiv (24, 23)$, $F \equiv (32, 12)$ and M be the mid-point of \overline{BC} . Then x -coordinate of M equals \dots .

Q29. Consider an acute angled $\triangle ABC$. \overline{AD} and \overline{CF} are altitudes such that point D is on line BC and point F is on line AB . \overline{AD} and \overline{CF} intersect at H . If $CD = 20$, $CB = 80$ and $CF = 64$ then HA equals \dots .

Q30. Point P is outside circle S . A secant through P cuts S at A and B . Among all points of S , M is the farthest point of S from P . If $PA = 28$, $PB = 100$, $PM = 140$ and area of $\triangle MPA = K$ then $\frac{K}{12}$ equals \dots .

Q31. Consider $\triangle ABC$. Point D is on \overline{AC} such that $AD = 2DC$. Point E is on \overline{AB} such that $AE = 2EB$. Points M, N are on \overline{BC} such that $BM = MN = NC$. \overline{MD} and \overline{NE} intersect at L . If area of $\triangle LMN$ equals 3 units then area of $\triangle ABC$ equals \dots .

Q32. In $\triangle ABC$, G is the centroid i.e. point of concurrency of all medians. M is the midpoint of \overline{BC} . Segment BE is an altitude such that point E lies on line AC . If $AM = 17$, $BE = 16$ and area of $\triangle CMG = 28$, then $((AB)^2 - 300)$ equals \dots .

Q33. $\square ABCD$ is a cyclic trapezium with $\overline{AB} \parallel \overline{DC}$. Let $AB = 14$, $CD = 50$, $BD = 40$. Let circle S pass through points A, B, C and D . Then radius of S equals \dots .

Q34. A circle S is fixed. A regular octagon is inscribed in S . Its perimeter is $32\sqrt{2} - \sqrt{2}$. An equilateral triangle is inscribed in the same circle. Area of the triangle is K . Then $(\sqrt{3}K + 5)$ equals \dots .

Q35. Consider the equation $\sqrt[3]{2x + 14} - \sqrt[3]{2x - 42} = 2$. Let J be the sum its roots. Then $(J - 700)$ equals \dots .

Q36. x is a real number. If $x^6 + \frac{1}{x^6} = 110$ then the value of $\left(x^8 + \frac{1}{x^8} - 450\right)$ equals \dots .

Q37. Let x_1, x_2, x_3, x_4 be the roots of $(x^2 + 7x - 40)(x^2 + 7x - 50) - 200 = 0$. Then $(|x_1| + |x_2| + |x_3| + |x_4|)$ equals \dots .

Q38. Let $45^\circ < A < 90^\circ$. If $2 \tan A + 3 \cot A = \frac{121}{20}$ then the value of $48 \tan \frac{A}{2}$ equals \dots .

Q39. Consider the equation $x^3 + 29x^2 - 21449x + 64059 = 0$. Its roots are a, b, c which are all integers.

If $a < b < c$ then $(a + 15b + c)$ equals \dots .

Q40. The coefficient of x^4 in the expansion of $\left(x^6 + x^4 + 2x^2 + 3 + \frac{4}{x} + \frac{5}{x^2} + \frac{6}{x^3}\right)^2 (x + 2)$ equals \dots .

M. Prakash Academy Entrance Exam 2013

Time: 1.30 pm to 5.00 pm

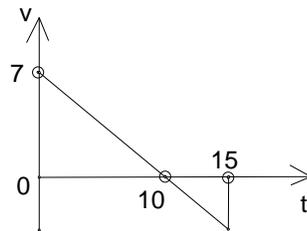
Total marks: 108

Important: All answers are to be marked as two digit numbers. If you get a non-integer answer, truncate your answer. E.g. if the answer is 59.31 or 59.57, mark it as 59.

Physics

Q01 A particle moving with constant acceleration travels distances $d_1 = 240$ m and $d_2 = 640$ m during the first two consecutive intervals of time, each of duration $t = 4$ s. Calculate the acceleration of the particle. Express your answer in m/s^2 .

Q02 The adjoining figure shows velocity time graph for the motion of a certain body moving in a straight line. Time in second is plotted on the horizontal axis and velocity in m/s is plotted on the vertical axis. Calculate the net displacement of the body in the time interval from $t = 0$ to $t = 15$ second.



Express your answer in meter.

Q03 Two motor-cyclists set off simultaneously from two points A and B towards each other. The one leaving point A moves with constant acceleration 2 m/s^2 and has initial velocity 72 km/h . The other, moving from point B, has same acceleration and initial velocity 36 km/hr . If the distance between A and B is 500 m, calculate the time after which they cross each other. Express your answer in second.

Q04 A metal ball is suspended from a light rope. The maximum tension that the rope can bear without breaking is five times the weight of the ball. The other end of the rope is now pulled up so that the ball begins to accelerate upward. What is the maximum allowed value of this acceleration? Take $g = 10 \text{ m/s}^2$. Express your answer in m/s^2 .

Q05 A block of mass $m = 10$ kg is placed on a rough horizontal surface and a constant horizontal force $F = 40$ N begins to act on it. When the block begins to move, a constant frictional force

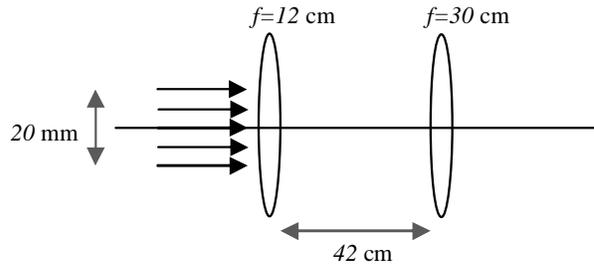
$f = 13 \text{ N}$ is exerted by the surface on it. Calculate the change in linear momentum of the block in time $t = 3 \text{ s}$ after the beginning of motion. Express your answer in kg m/s .

Q06 A bullet of mass 10 gm is fired from a gun with velocity 1000 m/s . It strikes a wall some distance away with velocity 600 m/s . The work done by air friction on the bullet during its flight is expressed as $W = n \times 10^2 \text{ J}$. Calculate n .

Q07 Consider three resistors $R_1 = 20 \text{ ohm}$, $R_2 = 10 \text{ ohm}$ and $R_3 = 5 \text{ ohm}$. All three are to be connected, in various combinations, across a battery of 10 volt . Calculate the ratio of maximum to minimum current that can be obtained from the battery.

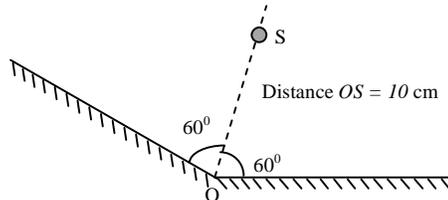
Q08 Consider a cylindrical wire of length 1 m and volume $2.5 \times 10^3 \text{ m}^3$. The resistivity of the material of the wire is 0.1 Ohm-meter . Calculate the resistance of the wire. Express your answer in Ohm .

Q09 A beam of light of diameter 20 mm is incident on a converging lens (convex lens) of focal length 12 cm . The beam is incident along the optic axis of the lens and falls symmetrically with respect to it. Another converging lens of focal length 30 cm is placed on the other side of first lens at a distance of 42 cm from it. Calculate the diameter of the beam emerging from the other side of the second lens.



Express your answer in mm .

Q10 Consider two flat mirrors inclined at 120° with each other. A point object S is placed at distance 10 cm from the intersection O of the mirrors, on the angle bisector. It is known that two images get formed. Calculate the distance between these two images.



Express your answer in centimeter .

Q11 A body weighs 100 N in air and weighs 85 N, when completely immersed in water. Let the density of the body be equal to d , expressed in gm/cc. What is the value of $10d$? Take density of water as 1 gm/cc.

Q12 Assume earth to be a perfectly spherical planet of uniform density. Take the present value of acceleration due to gravity $g = 10 \text{ m/s}^2$. Assume that the density decreased to 50% of its present value and radius increased to three times of its present value. What would be the new value of g ? Express your answer in m/s^2 .

Chemistry

Atomic weights of some elements are given below:

$Ca = 40$, $Na = 23$, $Fe = 56$, $Mg = 24$, $K = 39$, $Ag = 108$,

$H = 1$, $O = 16$, $N = 14$, $S = 32$, $P = 31$, $C = 12$,

$Cl = 35.5$, $F = 19$, $Al = 27$

Avogadro's number = 6.022×10^{23}

Q13 An element A has atomic number 15, in which group is this element placed in the modern periodic table?

Q14 Magnesium is burnt in an atmosphere of nitrogen to form a compound X . X reacts with HCl to form magnesium chloride and a gaseous substance Y . If 40 molecules of X are formed initially then how many molecules of Y will finally be formed?

Q15 An element B is in the third period of the modern periodic table and in the group IA. 46 g of B reacts with excess of water and into this solution 71 g of dry HCl gas infuses in. The pH of the resultant solution is X . $6X$ equals?

Q16 A is an element which is a soft, yellow powder. It is found in volcanic regions, and is extracted from the earth by the Frasch process. It is roasted in air to yield B which is gaseous. B on heating reacts in the presence of air and vanadium pentoxide to give C . C reacts violently with water to give D . In another experiment A on heating reacts with iron filings to give E . Now E reacts with D to give a gaseous substance F and a salt of iron. What is the summation of molecular weight of F and atomic weight of A ?

Q17 A is a white crystalline substance.

It is highly soluble in water. When A is heated in a test tube it sublimes and it reappears in cooler parts of test tube. In another experiment A is warmed with caustic soda and a colourless, pungent smelling gas is given off. The gas turns moist red litmus paper blue. A is dissolved in water. The solution of A reacts with a

solution of silver nitrate and a chalky white precipitate is formed. $XY.5$ is the molecular weight of A . What is XY ?

Q18 10 moles of barium chloride in solution are mixed with 30 moles of sodium sulphate to form a precipitate T . How many moles of T will be formed?

Q19 Methane gas is burnt in very limited supply of air. The products of combustion are water and black powder X . X is heated strongly till it is red hot and then steam is passed over it and two gases are produced. What is summation of the molecular weights of the two gases thus produced?

Q20 800 g of calcium carbonate is heated till there is 75% thermal decomposition to give A which is gaseous compound. The gas A produced reacts with sodium peroxide (Na_2O_2) to give sodium carbonate and oxygen. The number oxygen molecules produced are $XY.066 \times 10^{23}$. What is XY ?

Q21 X g of $CaCO_3$ are heated till it fully decomposes. The product reacts with water and allowed to dry. On passing chlorine over the dried powder 63.5 g of a dull yellow powder is formed. What is X ?

Q22 18.066×10^{23} molecules of oxygen are split into atoms and then recombined as ozone. If the actual volume of a single molecule of ozone is V cc, then the volume of all the molecules is $V \times AB.044 \times 10^{23}$. What is AB ?

Q23 From the elements given below choose the one that fits the description given below and then give its atomic number.



The elements produce brown solution when dissolved in KI solution. It is extracted from seaweed. At room temperature it exists in solid crystalline form. It is displaced when a solution of its salt is taken and chlorine is passed through it.

Q24 One molecule of butane reacts with one molecule of chlorine to give A along with HCl . A reacts with $NaOH$ to give B and $NaCl$. How many carbon hydrogen bonds are there in B ?

Mathematics

Q25 In $\triangle ABC$, median $AM = 17$, altitude $AD = 15$ and the circum-radius $R = 10$. Find BC^2 .

Q26 In $\triangle ABC$, internal bisector $AD = 60$, external bisector $AE = 80$ with the points D and E lying on line BC . The area of $\triangle ABC$

equals 696 sq. units. Find BC .

Q27 In $\triangle ABC$, I is the incenter. $IB = 10$, $IC = 17$ and inradius $r = 8$. Find $85 \cos\left(\frac{A}{2}\right)$.

Q28 Consider $\triangle ABC$. Draw circle S such that it touches side AB at A . This circle passes through point C and intersects segment BC at E . Altitude $AD = \frac{21(\sqrt{3}-1)}{\sqrt{2}}$ and $m\angle EAB = 15^\circ$. Find AC .

Q29 Consider $\triangle ABC$. Choose a point D on segment BC such that $\frac{BD}{DC} = \frac{1}{2}$. Choose a point E on segment AC such that $\frac{AE}{EC} = \frac{2}{3}$. Let segments AD and BE intersect at point P . If area of $\triangle PBD = 5$ sq. units, then find the area of $\square PDCE$.

Q30 $\square ABCD$ is a trapezium with $\overline{AB} \parallel \overline{DC}$. The trapezium has an incircle having radius $r = 6$. $AD = 13$, $BC = 15$.

Find $\frac{1}{4}$ (area of $\square ABCD$).

Q31 Circle S_1 has center at A_1 and radius $r_1 = 15$. Circle S_2 has center at A_2 and radius $r_2 = 5$. $A_1A_2 = 26$. Direct common tangent of these two circles touches S_1 at B_1 and S_2 at B_2 . Lines A_1A_2 and B_1B_2 intersect at point P . Find PB_1 .

Q32 x, y, z are positive real numbers which satisfy the following three equations.

$$x + 2y + z = 5(x + y)(y + z)$$

$$x + y + 2z = 7(y + z)(z + x)$$

$$2x + y + z = 6(z + x)(x + y).$$

Find the value of $(24)^3(xyz)$.

Q33 The following polynomial has integer roots. $x^3 + 30x^2 - 7377x + 14626 = 0$. Find the value of the largest root.

Q34 $\triangle ABC$ is drawn in the XY plane. G is its centroid.

$A = (2, 4)$ and $G = (14, 12)$. Let $B = (X_B, 21)$ and $C = (X_C, Y_C)$.

If $BC = 26$, find the value of $|X_B - X_C|$.

Note that $|K|$ denotes the absolute value of K .

Q35 Let $0 < A < 45$. If $420(\tan A + \cot A) = 841$ then find the value of $(116 \cos A - 58 \sin A)$.

Q36 a, b are positive real numbers. If $a^2 + b^2 = 22$ and $a^4 + b^4 = 386$ find the value of $(a^3 + b^3)$.

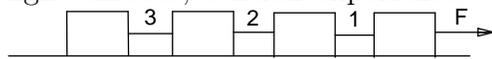
M. Prakash Academy Entrance Exam 2012

Physics

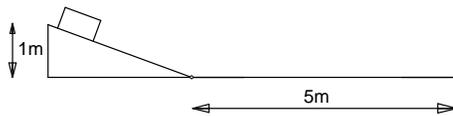
1. Two trains, each having a speed of 40 km/h , are headed for each other on a straight track. A bird that flies at 60 km/h takes off from the front of one train when they are 80 km apart and heads directly, in a straight line, for the other train. On reaching the other train it immediately flies back to the first train, and so forth. What is the total distance travelled by the bird before the trains crash? Express your answer in kilometer.

2. A ball is dropped from a height of 8 meter above the ground. After striking the ground the ball rebounds instantaneously with the same speed with which it struck the ground. The instant at which the ball strikes the ground, another ball is dropped from the same point and from the same height above the ground. Find the height (in meter) from the ground at which the balls collide. Neglect air resistance and size of the balls. Take $g = 10 \text{ m/s}^2$.

3. Four identical blocks, each of mass 5 kg , are connected by very light threads and are placed on a smooth table as shown. The rightmost block is pulled with the force of $F = 100 \text{ N}$. Let the tension in the first thread be T_1 and that in the third thread be T_3 . Calculate the ratio $T_1 : T_3$. Note that tension in a thread is the force with which it pulls objects tied to both its ends. For light threads, tension experienced at both the ends is the same.

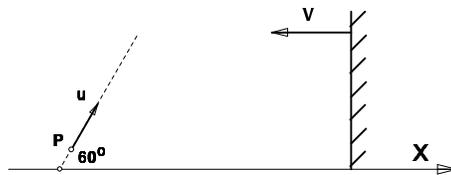


4. Let a body of mass M be moving on a rough horizontal surface. Assume that no vertical force other than gravity and reaction of the surface act on the body. Then the frictional force opposing the motion is given by $f = \mu Mg$, where μ is called coefficient of friction.



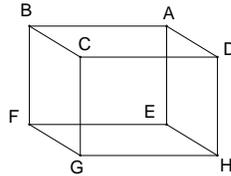
Now study the following situation: A block of mass $M = 10 \text{ kg}$ begins to slide down a *smooth* fixed incline of height 1 meter . After reaching the bottom, the block travels along the *rough* ground and stops after traveling a distance of 5 meter from the base of the incline. If μ is the coefficient of friction, calculate the value of 100μ . Take $g = 10 \text{ m/s}^2$.

5. A particle P is moving in a straight line with velocity $u = 10 \text{ cm/s}$ along the surface of a smooth table. Its line of motion makes angle $= 60^\circ$ with the X axis drawn on the surface of the table. A plane mirror oriented perpendicular to the surface of the table as well as the X axis is moving with constant velocity of $v = 20 \text{ cm/s}$.



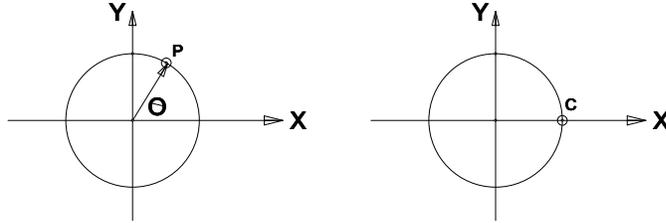
The velocity of the mirror is directed parallel to X axis from right to left. Calculate the relative speed (in cm/s) between the particle and its image.

6. Twelve wires of equal resistance and of equal length are connected so as to form a cube as shown in the figure.



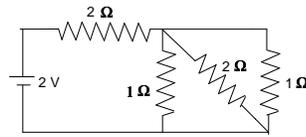
Equivalent resistance between points A and G is $\frac{5}{3} \text{ ohm}$. If a battery of voltage 100 V is connected across the points A and G , find the current (in *ampere*) flowing through the wire CD .

7. Consider a particle moving in anti-clockwise direction along the circumference of a circle. The center of the circle is at the origin of the coordinate system with X and Y axes. The arrow going from the center of the circle to the particle is called the position vector of the particle. Note that one end of the position vector is stationary and the other moves with the particle. The angle made by the position vector with the positive X axis changes continuously. We define angular velocity ω of the particle as the ratio of change in angle $(\theta_2 - \theta_1)$ to the time interval $(t_2 - t_1)$. Thus $\omega = (\theta_2 - \theta_1)/(t_2 - t_1)$ with the unit of measurement given by *degree/second*.



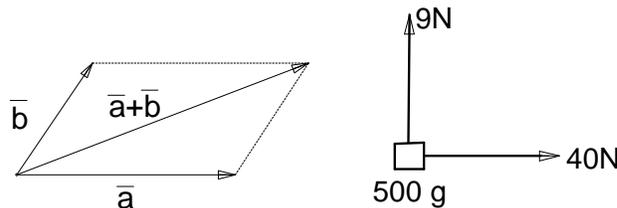
Now answer the following question: Two particles move along the circumference of a circle in anticlockwise direction. The particles start simultaneously from the same point C of the circle. The first particle moves with constant angular velocity ω_1 and the second moves with constant angular velocity ω_2 , where $\omega_1 = 5\omega_2$. Given that the particles meet again for the first time after 3 seconds. Find the angle (in *degree*) made by the position vector of second particle with the positive X axis, 1.5 seconds after the beginning of motion.

8. Consider a battery of voltage V_0 . When it is connected to an electric circuit and charge Q_0 passes through the battery in some time interval, the work supplied by the battery is equal to $W_B = Q_0 V_0$. Now consider the adjoining circuit:



Find the time (in *second*) in which the battery supplies 60 *Joule* of work.

9. Vectors are quantities that have magnitude and direction. Examples are force, velocity, electric field etc. Vectors are represented by arrows having appropriate magnitude and direction. Vectors are added using parallelogram law of addition, given below. Suppose we need to add two vectors \vec{a} and \vec{b} . We lay them at a common point and complete the parallelogram as shown. The diagonal of the parallelogram starting from the same common point denotes the addition of the two vectors.

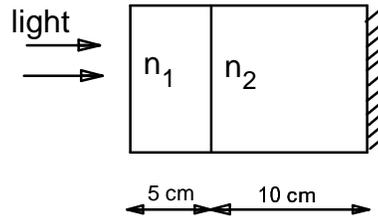


Now answer the following question: Two forces act simultaneously on a body of mass 500 gram . The magnitudes of the forces are 9 Newton and 40 Newton , and the angle between them is 90° as shown. Find magnitude of the acceleration of the body. Express your answer in m/s^2 .

10. An object is placed at a distance of 10 cm on the left side of a convex lens of focal length 5 cm . A concave lens of focal length 10 cm is placed on the right side of the convex lens. The distance between the lenses is 25 cm . Note that the image formed by one lens may act as object for the other lens. Calculate the distance of the final image from the concave lens. Express your answer in cm .

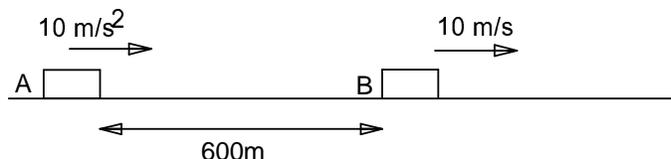
11. Starting from one corner of a cube, an ant has to travel to the diagonally opposite corner along the shortest path. Assume that the ant can move only along the faces of the cube. Calculate the number of possible paths that the ant may follow.

12. Refractive index of a material with respect to vacuum is defined as the ratio of speed of light in vacuum (c) to the speed of light in that material (v). Thus refractive index $n = c/v$. Consider two slabs of thickness 5 cm and 10 cm and made of different types of glasses with refractive indices $n_1 = 1.5$ and $n_2 = 2.0$, both defined with respect to vacuum. The slabs are pasted together as shown. One face of the second slab (shown as shaded face in the figure) is silvered so that it reflects light falling on it from inside.



Now as shown in the figure, a ray of light falls perpendicularly on the face of the first slab. Let it emerge from the same face after time interval $t = a \times 10^{-10} \text{ second}$. Express the number a to the nearest integer.

13. Two cars A and B are initially at a distance of 600 m from each other. They start moving simultaneously from rest. Car A moves with constant acceleration of 10 m/s^2 and car B moves with constant velocity of 10 m/s as shown in the figure.



Find the time (in *second*) at which car A overtakes car B.

Chemistry

Atomic weights of some elements are given below: $Ca = 40$, $Na = 23$,

$Fe = 56$, $Mg = 24$, $K = 39$, $Ag = 108$, $H = 1$, $O = 16$, $N = 14$,
 $S = 32$, $P = 31$, $C = 12$, $Cl = 35.5$, $F = 19$, $Al = 27$

Questions 14 and 15 are based on the following statement.

24 molecules of quick lime react with excess of water to form a compound X, X reacts with nitric acid to form Y.

14. How many molecules of nitric acid are needed to fully react with X?

15. How many oxygen atoms are there on a molecule of Y.

16. Compound [I] is Fe_2O_x and compound [II] is Fe_2O_y . The conversion of [I] to [II], is an oxidation reaction. Now in another experiment 6 molecules of the compound [II] are dissolved completely in HCl and a salt is produced. How many chloride ions are associated with all the iron in the salt?

Question 17 and 18 are based on the statement below.

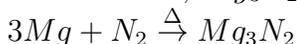
A salt X of aluminium in the form of dry powder is heated strongly and a gas Y is given off. Y when passed through lime water turns it milky.

17. What are the number of oxygen atoms in a molecule of X?

18. When excess of Y is passed through lime water then Z is produced which is fully soluble and produces a colourless solution. What is the valency of the anion in Z?

Question 19 and 20 are based on the following statement.

36 g of magnesium reacts with nitrogen on heating to give magnesium nitride, Mg_3N_2 ,



Mg_3N_2 reacts with water as follows



19. How many moles of ammonia are formed ?
20. When the magnesium hydroxide formed in the above experiment is mixed with 3 moles of HNO_3 what is the pH of the resulting solution ?

21. When sulphur di oxide gas and hydrogen sulphide gas are bubbled through water they react to give a milky white suspension due to the formation of an element which remains in suspended form in water. 10 molecules of sulphur di oxide react with 30 molecules of hydrogen sulphide. How many atoms of the element which is a product have been formed?

Question 22 and 23 are based on the following paragraph.

A 10% solution of sodium chloride solution is made to undergo electrolysis and a compound X is formed which remains in solution form. Two gases B and C are also formed.

22. X reacts with carbon dioxide to give a salt. This salt is crystallized and is associated with a certain number of water of crystallization. The salt is used in detergents. What is the number of water molecules of crystallization associated with a molecule of the salt?

23. The gas B is formed in the experiment described in the above paragraph, has a pungent smell. B is passed over cold dry slaked lime to give a product D . What are the number of oxygen atoms that are there in a molecule of the product D

24. The number of carbon oxygen single bonds in a molecule of ethanol is x , in acetaldehyde is y and in acetic acid is z . What is $x + y + z$ equal to?

25. The molecular formula of an organic molecule is $CH_3CH_2CONH_2$, What will be the difference in molecular weight of this compound and the one that comes next to it in the homologous series?

26. Bauxite is subjected to the process of leaching by the Bayer's process. The product is melted with fluorspar and cryolite and subjected to electrolysis X is obtained at the cathode. In another experiment some iron nails are left in moist atmosphere till they change to a reddish brown powder Y . Now X and Y are packed into a crack in an iron girder. The mixture is ignited with a magnesium ribbon. A metal is formed in molten state which fills up the crack. What is the atomic weight of the metal?

Maths

27. Circle with center A and radius 3, circle with center B and radius 24 and circle with center C and radius 27 touch each other externally, i.e. every circle touches the remaining two circles. Find the inradius of $\triangle ABC$.

28. $A = (5, 3), B = (9, 5), C = (x_o, y_o), D(4, 1)$ are the vertices of $\square ABCD$. $\angle BAC \cong \angle DAC$. Diagonals AC and BD meet at M . M is the mid point of AC . Find the value of $3x_o + 9y_o$.

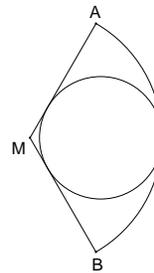
29. $p(x) = x^4 + 5x^3 + 4x^2 - 3x + 9 = (x - k)^2(ax^2 + bx + c)$ where k is an integer and a, b, c are constants. Find the value of $5a - 7b + 8c$.

30. Find the value of $x^2 + y^2 + z^2$ given
 $x + y + 2z = 22, \quad 3x - 2y + z = 6, \quad 7x + 3y - 5z = 1$.

31. A contractor employed a certain number of men to complete a work in a certain number of days. If 3 more men were deployed the work would be finished 2 days earlier while if 12 more men were deployed it would be finished 5 days earlier. Find number of men deployed by the contractor.

32. Given : $4(x^2 + 2x + 1)(x^2 + 3x - 2) + (x - 3)^2 = (ax^2 + bx + c)^2$. Find $a^2 + b^2 + c^2$.

33. Consider sector of circle MAB . $m\angle AMB = 120^\circ$. A circle S touches side AM , side MB and arc AB as shown in the figure. Area of circle S is $\frac{75\pi}{7 + 4\sqrt{3}}$.



Find $4\sqrt{3}$ times the area of $\triangle AMB$.

34. Consider an acute angle $\triangle ABC$. Points D, E, F are mid points of sides BC, CA and AB respectively. G is the centroid of $\triangle ABC$.

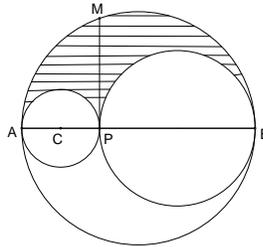
Area of $\triangle AFG = 14, EC = \frac{15}{2}$. Perpendicular distance of F from $BC = 6$. Find $BC^2 - AB^2$.

35. $0^\circ < A < 90^\circ$. $6 \sec A - 3 \cos A = 7$.
Find the value of $4 \tan^2 A + 15 \operatorname{cosec}^2 A$.

36. $\square ABCD$ and $\square PQRS$ are squares. Side AB is parallel to side PQ . $\square PQRS$ lies completely inside $\square ABCD$. Let area of trapezium $BQRC = 42$, area of trapezium $DSPA = 14$ and $PS = 3$. Find BC .

37. In $\triangle ABC$, I is the incenter. Area of $\triangle IBC = 28$, area of $\triangle ICA = 30$ and area of $\triangle IAB = 26$. Find $AC^2 - AB^2$.

38. Consider circle S with AB as diameter. Let P be a point on diameter AB . Let C_1 be a circle with AP as diameter and center C . Let C_2 be a circle with PB as diameter. Tangent to C_1 and C_2 at P meets S at M as shown in the figure.



Area of circle C_1 is 4π . Area of shaded region is 9π . Find the area of $\triangle MCB$.

39. In $\triangle ABC$, coordinates of B are $(-3, 3)$. Equation of the perpendicular bisector of side AB is $2x + y - 7 = 0$. Equation of the perpendicular bisector of side BC is $3x - y - 3 = 0$. Mid point of side AC is $E(\frac{11}{2}, \frac{7}{2})$. Find AC^2 .

40. x and y are real numbers and $x > y$.
Given $x^2 - xy + y^2 = 15$, $xy + x + y = 13$. Find the value of $x^2 + 6y$.

April 2016 Answers

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	
A	58	47	2	75	15	6	60	42	98	72	7	17	7	
Q	14	15	16	17	18	19	20	21	22	23	24	25	26	
A	75	88	50	70	48	9	60	25	75	88	20	25	06	
Q	27	28	29	30	1	32	33	34	35	36	37	38	39	40
A	40	50	30	45	71	49	12	29	45	99	16	35	12	65

April 2015 Answers

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	
A	30	5	7	60	34	3	11	77	50	10	10	90	44	
Q	14	15	16	17	18	19	20	21	22	23	24	25	26	
A	40	18	25	20	32	17	10	80	24	56	48	10	29	
Q	27	28	29	30	1	32	33	34	35	36	37	38	39	40
A	60	24	34	65	38	48	33	70	62	27	64	76	45	81

April 2014 Answers

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	
A	05	50	21	40	07	27	13	23	24	60	48	68	33	
Q	14	15	16	17	18	19	20	21	22	23	24	25	26	
A	20	82	63	24	01	88	52	15	60	40	58	36	96	
Q	27	28	29	30	1	32	33	34	35	36	37	38	39	40
A	75	35	65	98	81	37	25	41	36	79	30	32	13	60

April 2013 Answers

Q	1	2	3	4	5	6	7	8	9	10	11	12	
A	25	26	10	40	81	32	12	40	50	17	67	15	
Q	13	14	15	16	17	18	19	20	21	22	23	24	
A	15	80	42	66		10		18	50	12	53	09	
Q	25	26	27	28	29	30	1	32	33	34	35	36	
A	76	29	84	42	22	42	36	35	71	24	44	90	

April 2012 Answers

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	
A	60	06	03	20	25	10	45	36	67	06	06	18	12	
Q	14	15	16	17	18	19	20	21	22	23	24	25	26	
A	48	06	36	09	01	01	07	23	10	01	02	14	56	
Q	27	28	29	30	1	32	33	34	35	36	37	38	39	40
A	06	34	20	83	12	30	75	27	32	11	56	33	74	29