ANSWERS TO GENERAL PAPER, 2014

1. **B:** Deficiency of **Vitamin B_1** (Thiamine) causes Beriberi, which is characterized by muscle wasting and paralysis. [See Q.33, 2008 for details of Vitamin deficiencies]. **Goitre** is commonly caused by **Iodine** deficiency. **Scurvy - Vitamin C** deficiency. **Pellagra - Vitamin B_3** deficiency.

2. **D:** A guard cell has the following components/parts:
(i). Large central vacuole (ii). Nucleus (iii). Chloroplasts (iv). Thick inner wall (v). Cell wall.
The opening of the guard cell is the stomata and the guards cells are surrounded by epidermal cell.
There is a catch to this question; the inner wall of the guard cell is **thick** not thin! **[Also see Q.21, 2011]**

3. **C:** The enzymes for the **Kreb's** (tricarboxylic acid) **cycle** is located in the mitochondria.

4. **B:** Photosynthesis has two stages of chemical reaction:
(i). Light stage (occurs in the thylakoids or grana discs. Here water is split by light)
(ii). Dark stage (occurs in the cytoplasm and the stroma. Here CO_2 is reduced to carbohydrates)
In both stages the chloroplasts are involved.
The **Light Reaction** is the first stage in photosynthesis, where water is broken in the chlorophyll molecule into H^+ and OH^- in the presence of light resulting in the formation of NADPH and ATP.
The **Dark Reaction** is the second step; it is independent of light. This stage is purely enzymatic and is slower than the Light Reaction. In the Dark Stage, sugars are synthesized from CO_2 in a process described as **Carbon fixation**.

5. In man, the diploid number (2n) of chromosomes is 46. It refers to the number of chromosomes present in a somatic (i.e. non-sex) cell. Also, the haploid number (n) refers to the number of chromosomes present in a sex cell (gamete, i.e. non-somatic cell). This number is half the diploid number i.e. 23 in man.

A

6. The region of the marine habitat extending over the continental shelf is called the **littoral zone**, while the **benthic zone** extends over the continental slope. The littoral zone is subdivided into the **slash zone, intertidal zone** and the **subtidal zone.**

D

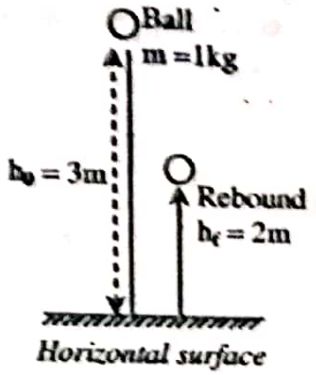
7. Involuntary actions are controlled by the Medulla Oblongata

A

NB: The **Cerebellum** is principally concerned with control of balance and posture of the body.
The **Cerebrum** is concerned with the control of voluntary actions such as speech and memory. It is the seat of intelligence.
The **Pineal body** has no well-known function(s) in man but was thought to function as a "third eye" in some primitive organisms such as the *Tautara* lizard.

8. **B**

9.



Energy lost, $E = mg(h_0 - h_f)$. Where h_0 = initial height and h_f = final height.

$E = 1 \times 10 (3 - 2) = 10$ J.

C

10. Maximum Range, R_{max} is attained when the angle of projection $\theta = 45°$.

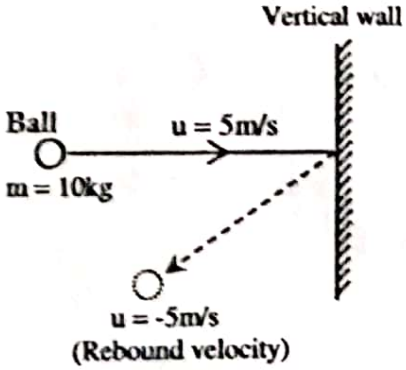
Hence: $R_{max} = \frac{u^2}{g}$ Where u = velocity of projection.

$40 = \frac{u^2}{10}$, $u^2 = 40 \times 10 = 400$

$u = \sqrt{400} = 20$m/s

C

11.



NB: (i). Impulse is defined as the product of force and time taken i.e. $I = F \times t$

(ii). Impulse can also be defined as the change in momentum. i.e. $I = mv - mu$

Either of the formulae above can be chosen based on the parameters in the question. From the question, we know the mass of the ball as well as the initial and rebound velocities. Also note that rebound velocity is always negative. Thus:

$I = mv - mu = m(v - u)$

$= 10 (-5 - 5) = 10 \times -10 = 100$ kg.m/s

Note: the negative sign can be neglected because it only shows that impulse decreased.

Thus impulse = 100 kg.m/s.

D

12. The wave equation:

$Y = 20 \sin(60\pi x - 0.5\pi x)$

Attention! The wave equation in the question is wrong! The standard wave equations are

(i). $Y = A\sin\frac{2\pi}{\lambda}(vt - x)$

(ii). $Y = A\sin\left(\frac{2\pi t}{\lambda} - \frac{2\pi x}{\lambda}\right)$

(iii). $Y = A\sin(2\pi ft - kx)$

(iv). $Y = A\sin(\omega t - kx)$

You may choose to write the correct form of the equation in the question, thus:
$Y = 20\sin(60\pi t - 0.5\pi x)$
This equation corresponds to the wave equation (iv) above. On comparison, $\omega = 60\pi$ and $k = 0.5\pi$

Velocity of a wave $v = \frac{\omega}{k} = \frac{60\pi}{0.5\pi} = 120 m/s$ **D**

13. **D**

14. Solve for the parallel connection first. C_1 and C_2 are in parallel. Diagrammatic representation is given below:

$C_1 = 2\mu F$
$C_2 = 2\mu F$ } In parallel

In Parallel: $C_T = C_1 + C_2$
$= 2\mu F + 2\mu F = 4\mu F$

From the question, this C_T above is now placed in series with $4\mu F$ (say C_3, illustrated below)

C_T C_3 } Series

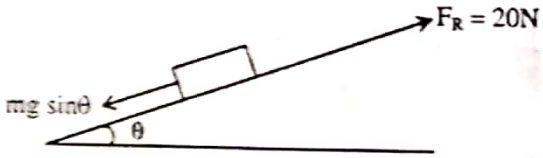
In series: $C_{eff} = \frac{C_T \times C_3}{C_T + C_3} = \frac{4\times4}{4+4} = \frac{16}{8} = 2\mu F$

C

You may otherwise use the relationship:

$$\frac{1}{C_{eff}} = \frac{1}{C_T} + \frac{1}{C_3}$$

15.



Note that from the question, the body was described to be resting on the inclined plane. Hence it follows that the limiting frictional force acts to balance out the component of weight down the plane.
Thus: $F_R = mg \sin\theta$ [F_R = frictional force]

$\sin\theta = \frac{F_R}{mg} = \frac{20}{4\times10} = \frac{20}{40} = 0.5$

$\theta = \sin^{-1}(0.5) = 30^\circ$

Hint: $W = mg \sin\theta$ (for an inclined object) **D**
$R = mg \cos\theta$ (for an inclined object)

16. C: Work done.

17. Centripetal force, $F_c = \frac{mv^2}{r}$ Where $v = \omega r$ (for SHM)

$$\therefore \quad F_c = \frac{m(\omega r)^2}{r} = \frac{m\omega^2 r^2}{r} = m\omega^2 r$$

$$F_c = m\omega^2 r$$

B

18. **Efficiency of a cell of Resistance, R is given as:**

$$e = \frac{R}{R+r} \times 100$$

Where R = External Resistance = 7Ω, r = Internal Resistance = 3Ω

$$\therefore \quad e = \frac{7}{7+3} \times 100 = 70\%$$

A

19. **Polymerization leads to the formation of polymers. All are polymers in the options except petroleum (which is a mixture)**

C

20. *

21. **B**

Entropy is a measure of the ***degree of disorderliness*** (randomness) of a system. Entropy becomes positive when there is an increase in the disorderliness of the system, and becomes negative when there is a decrease in the disorderliness of the system (i.e. the system becomes more orderly). For example the change of water to vapour during **boiling** increases the entropy of the water molecules (i.e. entropy is positive); the change of water to ice during **freezing** decreases the entropy of the water molecules (i.e. entropy is negative). Entropy is denoted as "S" and the unit is $JK^{-1}mol^{-1}$.

For a reversible reaction that occurs at a constant temperature, the change in entropy, ΔS, equals the heat absorbed or evolved, ΔH, divided by the absolute temperature (in Kelvin), T. i.e.

$$\Delta S = \frac{\Delta H}{T}$$

If heat is absorbed by the system, entropy change, ΔS, is positive (endothermic reaction). If heat is evolved, entropy change is negative (exothermic reaction).

Enthalpy (H) refers to the **heat contents** of either reactants or products. The difference between the heat contents of the products and that of the reactants is called "enthalpy change" and denoted as ΔH.
That is, enthalpy change, $\Delta H = H_2 - H_1$. Where H_2 = heat content of products and H_1 = heat content of the reactants.
ΔH may be positive (endothermic reaction) or it may be negative (exothermic reaction).

The **Gibb's Free Energy (G)** is the ***"energy available to do work"*** it may be positive, zero or negative
If Free Energy is positive, the reaction cannot take place. Rather, the reverse of the reaction takes place. If "G" is zero, it shows that the reaction system is at equilibrium (i.e. the rate of forward and backward reactions are the same). If "G" is negative, then the reaction takes place on its own (spontaneously), without external influences.

The relationship that connects Free Energy change (ΔG), Enthalpy change (ΔH), absolute temperature (T) and Entropy change (ΔS) is:

$$\Delta G = \Delta H - T\Delta S$$

Activation Energy (E_a) is the minimum amount of energy reactant molecules must possess for a reaction (effective collision) to take place. This is because for every reaction, there is certain ***energy barrier*** that reactants must surmount or overcome to be able to combine chemically.
Catalysts speed up the rate of a chemical reaction by **lowering the activation energy.**

22. Let's calculate the oxidation number of chromium in $Cr_2O_7^{2-}$

$Cr_2O_7^{2-} = 2Cr + 7O = -2$

$= 2(Cr) + 7(-2) = -2$

$= 2(Cr) + (-14) = -2$

$= 2(Cr) = -2 + 14 = +12$

$$Cr = \frac{+12}{2} = +6$$

Meanwhile, on the right hand side of the equation, oxidation state of Chromium is obviously +3. Therefore the change in oxidation number is from +6 to +3.

B

23. **C**

24. The Alloy used for wielding and plumbing is soft solder. Its constituent elements are lead and tin.

A

25. Every hydrocarbon conforms to the formula CxHy. The combustion of hydrocarbons is represented using the general equation:

$$CxHy + (x + \frac{y}{4})O_2 \rightarrow xCO_2 + yH_2O$$

x and y can be calculated as follows:

$$x = \frac{volume\ of\ CO_2\ produced\ (x)}{volume\ of\ hydrocarbon\ (1)} = \frac{45cm^3}{15cm^3} = 3$$

Meanwhile: $(x + \frac{y}{4}) = x = \frac{volume\ of\ O_2\ used}{volume\ of\ hydrocarbon} = \frac{75cm^3}{15cm^3} = 5$

But x = 3

$$\therefore \quad 3 + \frac{y}{4} = 5, \qquad \frac{y}{4} = 5 - 3 = 2, \qquad y = 4 \times 2 = 8$$

Therefore the molecular formula of the hydrocarbon is C_3H_8

C

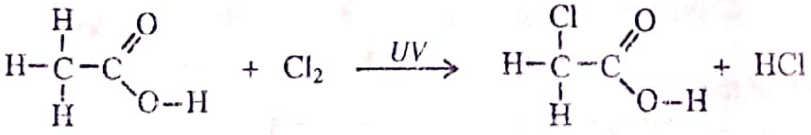
26. **C**

27. The photochlorinaton of alkanoic acids refers to their reaction with chlorine in the presence of ultraviolet light. The outcome of the reaction is the same as when a catalyst of red phosphorus, PCl_3 is used. The final result is that the chlorine atom adds on to Carbon-2 (the alpha carbon) while the carboxyl group (COOH) is unaffected:

$$R{-}CH_2{-}CH_2{-}COOH + CH_3 \xrightarrow{UV} R{-}CH_2{-}CH(Cl){-}COOH$$

In the case of ethanoic acid, we have:

$$Cl_2 + CH_3{-}COOH \xrightarrow{UV} CH_2(Cl){-}COOH + HCl$$



D

The name of this reaction is the "Hell-Volhard-Zelinsky Reaction" (after Carl Hell, Jacob Volhard and Nicolai Zelinsky), especially when it involves bromine in the presence of P or PBr_3.

28. The reaction between ammonia and an ester is called AMMONOLYSIS (splitting by means of ammonia) of the ester. The products are usually an amide, corresponding to the carboxylic acid part of the ester and the alcohol of the ester. In this case we have:

$$CH_3COOC_2H_5 + NH_3 \rightarrow \underset{\text{Ethanamide}}{CH_3CONH_2} + \underset{\text{Ethanol}}{C_2H_5OH}$$

C

29. Effervescence usually signifies the release of a gas during a reaction. Adding water to Calcium results in effervescence due to the release of hydrogen gas.

A

30. Charring of sugar occurs when it is dehydrated by concentrated tetraoxosulphate (VI) acid. The charred sugar is also called sugar charcoal.

$$C_6H_{12}H_6 \xrightarrow{H_2SO_4} \underset{\text{Sugar charcoal}}{6C} + 6H_2O$$

31. The liberation of Zinc from an electrolyte prode solution during an electrolysis can be represented as follows:

$$Zn^{2+}_{(aq)} + 2e^- \rightarrow Zn_{(s)}$$

The equation shows that 2F of electricity liberates 1mole of Zinc.
Therefore 3F of electricity will liberate x moles of Zinc.

$$x = \frac{3 \times 1}{2} = 1.5 moles$$

A

32. **C**

33. Electric force, otherwise called electrostatic force, F_e. For unlike charges (-q and +q) is positive since according to Coulomb's Law, they will attract and vice versa.

Thus from: $F = \frac{k_0 q_1 q_2}{r^2}$ Where $k_0 = \frac{1}{4\pi\varepsilon_0}$ and k_0 = electrostatic force constant in Air.

$q_1 = -q$ and $q_2 = +q$ and $r = x$.

NB: q_1 and q_2 are unlike charges, hence they will attract (positive).

$$\therefore F = \frac{q^2}{4\pi\varepsilon_0 x^2}$$

C

34. **A**

35. From the question, it is a complete circuit containing R (resistor), I (inductor) and C (capacitor), hence the Impedance for the circuit, $Z = \sqrt{R^2 + (X_L - X_C)^2}$

Therefore, Power "P" will no longer be = I^2R, but $P = I^2Z$. This is because the circuit is not just made of Resistance only.

Hence, $P = I^2\sqrt{R^2 + (X_L - X_C)^2}$

A

36. **Anaerobic respiration** involves the degradation of glucose in the absence of oxygen. The products of the process are usually carbon (IV) oxide and ethanol (in plants) or lactic acid (in animals). Water is not usually formed.

A

37. Meiotic cell division, or simply **meiosis**, occurs during the formation of sex cells **(gametes)**. All of the listed processes lead to the formation of gametes except "cell division at the tip of the roots or cambium cells"

A

38. Dentition is **homodont** when all of the teeth of an organism are the same in form and number. Heterodont organisms on the other hand, have teeth that are different in form and number. Only mammals have heterodont dentition; all other vertebrates (Fishes, Amphibians, Reptiles etc) have homodont dentition.

A

39. **C**: The other options are parts of the nephron. The **nephron** is the functional unit of the kidney.

40. **A**

41. **D**

42. **B**

	Defect	Correction
1.	Myopia (short-sightedness)	Concave (diverging) lenses
2.	Hypermetropia (long-sightedness)	Convex (converging) lenses
3.	Astigmatism	Cylindrical lenses
4.	Night blindness and Xeropthalmia	Vitamin A supplementation
5.	Presbyopia	Bi-focal lenses.

43. All Arthropods have antennae. The exception to this rule is the Arachnids such as spiders, ticks and mites.

A

44. **Haemolysis** means the breakdown of the red blood cell membrane and leakage of its content haemoglobin. **Crenation** on the other hand refers to a shrinking of the red blood cell so that its edges become scalloped. It is usually due to the being placed in a hypertonic solution.

A

45. $pH + pOH = 14$

$\therefore pOH = 14 - pH = 14 - 10 = 4.0$

$pOH = -\log [OH^-]$

$\therefore [OH^-] = \log^{-1} [-pOH]$

$= \log^{-1} [-4.0] = 10^{-4}\ mol.dm^{-3}$

B

NB: When the pH of a solution is x for instance, the hydrogen ion concentration $[H^+]$ is equal to 10^{-x}. For instance in this question with a pH of 10, $[H^+] = 10^{-10}$. Also, $[H^+] \times [OH^-] = 10^{-14}$. Using this last relationship to solve:

$pH = 10$,

$[H^+] = 10^{-10}$

$[H^+] \times [OH^-] = 10^{-14}$ $\quad \therefore [OH^-] = \dfrac{10^{-14}}{10^{-10}} = 10^{-4}$ ... This same as the answer gotten above!

4C. **A: Alkaline pyrogallol** absorbs oxygen whereas the items in the other two options absorb water and are used as drying agents.

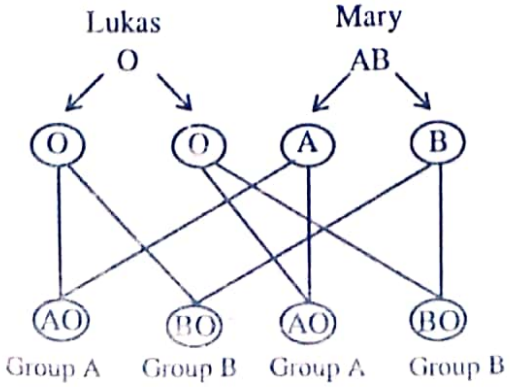
47. **B**: *Chlamydomonas reinhardtii* is a single-celled green alga.

48. Carnivorous Plants are those plants that can trap insects mainly to absorb **Nitrogen** from them. Examples of these carnivorous or insectivorous plants are:

(i). The Pitcher plants
(ii). The Sundews (*Drosera*)
(iii). The Venus flytrap (*Dionaea muscipula*)
(iv). Urtricularia (the bladderworts)
(v). Byblis
(vi). Genlisea

C

49.



A

[Please see Q.1, 2007 for blood grouping]

50. B

$SO_{2(g)} + H_2O_{(l)} \rightarrow H_2SO_{3(aq)}$