ANSWERS TO BIOLOGICAL SCIENCES 2011

PAPER TYPE B

1. The **evolutionary trend** of vertebrates shows five classes;

Pisces (fishes) → ***Amphibia*** → ***Reptilia*** →***Aves (birds)*** → ***Mammalia***

Rattus rattus is the black rat. *Agama agama*, is the common lizard; *Bufo regularis* is the African toad (Egyptian or square-marked toad) while *Tilapia zilli* is the red belly tilapia fish, (a member of the class Pisces). Thus the evolutionary trend of the named vertebrate is:

Tilapia zilli → *Bufo regularis* → *Agama agama* → *Rattus rattus* i.e.

d → c → b → a

A

The first three members of subphylum vertebrata (i.e. Pisces, Amphibia and Reptilia) are **cold blooded animals** or **poikilothermic** (ectotherms), while the last two (Aves and Mammalia) are **warm blooded animal** or **homoiothermic**. Reptiles, bird and mammals produce amniotic egg. Fishes and amphibians do not.

2. **C**

The **sperm cell** is the male gamete. It has a head, middle- piece and tail. The middle piece contains numerous mitochondria which provides the ATP needed for movement of the sperm cells into the oviduct (fallopian tubes in humans) where they fertilize the ovum (female gamete).

3. **A**

Maize rust is a fungal disease. The other diseases are caused by viruses. See 2007, Q.24 for more details.

4. **C**

Urea is formed by deamination of amino acids in the liver (the urea cycle). Formation of urea is the major means by which the body gets rids of nitrogenous substances in the form of excess amino acids, ammonia and other amino-compounds.

The **functions of the kidneys** include:

i. Excretion of unwanted substances e.g. urea, creatinine, drugs,
ii. Activation of Vitamin D
iii. Maintenance of normal ion (electrolyte) concentrations of plasma
iv. Enhancement of red blood cell production (via the action of a hormone called erythropoietin)
v. Control of blood pressure
vi. Maintenance of the body's acid-base balance
vii. Maintenance of the amount of body water,

(Other excretory organs in humans include the skin, liver, and lungs).

The **pancreas** has <u>two parts</u>:

i. An **endocrine** part which produces the hormones ***insulin*** (β cells of pancreatic islets) and ***glucagon*** (α cells of pancreatic islets). Insulin reduces blood glucose while glucagon raises blood of glucose.
ii. An **exocrine** part which produces ***pancreatic juice***. The pancreatic juice contains digestive enzymes such as **lipases** (digests fat and oil), **proteases** (digest proteins) and amylases (digests carbohydrates).

The end-products of **lipid digestion** are <u>fatty acids and glycerol</u>, while for **proteins** it is <u>amino acids</u>. <u>Glucose, fructose and other simple sugars</u> such as galactose, xylose, mannose etc are produced at the end of **carbohydrate** digestion.

The liver stores vitamins and minerals, plays a role in the formation and break down of red blood cells, inactivation of hormones and production of heat. (See 2009, Q.4 and 2010, Q.4 for more information).

5. **A**

Prolactin is the hormone that enhances milk production (lactation) in the breasts. This hormone is produced from the anterior pituitary gland.
However, **oxytocin** is the hormone responsible for milk ejection (milk let-down) from the breasts during breastfeeding.
The **oestrogens** refer to the female sex hormones which play a number of roles such as:

i. Development of the female sexual characteristics e.g. mammary glands
ii. Widening of the hips (pelvis)
iii. Fat redistribution
iv. Growth of hairs in the pubic regions and armpits.

These changes seen in a female from puberty are referred to as ***secondary sexual characteristics***.
Deficiency of oestrogens cause poor development of female secondary sexual characteristics.

Insulin lowers blood glucose (sugar) levels. Absence or deficiency of insulin causes ***diabetes mellitus***.
Thyroxine (a hormone from the thyroid gland) regulates the growth and development of body cells. The hormone increase the body's ***basal metabolic rate*** (i.e. the rate of which glucose and other molecules are broken down to yield energy). Deficiency of thyroxine before maturity of a child causes **cretinism** (dwarfism, mental retardation, sexual immaturity and sluggishness). Deficiency of thyroxine after maturity causes **myxoedema** (physical and mental sluggishness, obesity, reduced heart rate and reduced metabolic rate).

6. Comparison of **nervous coordination** to **hormonal** (endocrine) **coordination**.

a. **Similarities**

i. They are both involved in maintenance of functions necessary for life
ii. They are linked together by the hypothalamus
iii. Some form of chemical change is involved in their activity

b. **Differences**

	Nervous system	Endocrine system
1. Mode of transmission	Information is relayed as electrical impulse	Information is relayed as chemical substances (hormones)
2. Means of transmission	Information is transmitted via nerve fibres and it is very fast	Transmission is via the circulatory system (through blood) and is its relatively slow
3. Effects	Localized and short- lived	Widespread, long-lasting or permanent
4. Response	Immediate, short-lived and precise	Slow, long-lasting and widespread

To answer the question: Nervous control is a fast process; it involves both electrical and chemical reactions; produces short term changes and has specific pathways,

7. **C** **C**

NB: Iron (Fe^{2+}) is required for formation of haemoglobin present in red blood cells; Ca^{2+} is required for muscle contraction as well as other intracellular metabolic activities.

8. **D**

Schistosomiasis (bilharziasis) is caused by the blood flukes *Schistosoma haematobium*, *Schistosoma mansoni* and *Schistosoma japonicum*. The disease is characterized by passage of blood in urine and stools. It is contracted by wading (e.g. swimming), bathing in or drinking water contaminated with the cercariae of the blood flukes.

Onchocerciasis (river blindness) is caused by *Onchocerca volvulus* (a filarial worm) transmitted by the bite of the black fly or Simulium fly. The fly breeds near rivers and streams. In humans, the adult worms lies below the skin, forming nodules, while the microfilaria migrate throughout the body. Those that reach the eye cause blindness if the disease is not treated.

Poliomyelitis is characterized by flaccid paralysis (weakness) of the limbs. It is caused by the polio virus.

Tetanus (lock- jaw) is caused by the obligate anaerobic bacteria, *Clostridium tetani*. It is contracted by contact of injured skin with soil, dust, animal faeces (droppings), rusty nails (e.g. in puncture wounds) which have been contaminated with the spores of the bacteria,
See 2006 Q.43, 2008 Q.25 and 2010 Q.7 for more information.

9. **C**
e.g. In sperm cells that do require energy (ATP) to swim, in order to meet the egg cell (ovum).

10. **B**
The brain may be sub divided into three regions **forebrain**, **midbrain** and **hindbrain**.
The **forebrain** is made up of the cerebrum, thalamus and hypothalamus. The **cerebrum** is concerned with **higher mental activities** (e.g. learning, memory, reasoning, intelligence), controlling voluntary activities (e.g. talking) coordinating involuntary activities (e.g. receiving sensory information, processing it and sending out the appropriate body response). The **thalamus** receives sensory inputs to the brain and "forwards" them to the appropriate centres within the brain. It also coordinates outgoing impulses from the cerebral cortex. The **hypothalamus** is the link between the nervous system and the endocrine (hormonal) system. It is responsible for regulating body temperature, sleep, thirst, hunger, hormone levels in blood as well as metabolite levels.
The **midbrain** connects the forebrain to the hindbrain. It is concerned with control of certain reflexes associated with sight and hearing.
The **hindbrain** is composed of the cerebellum, pons varolii, and medulla oblongata.

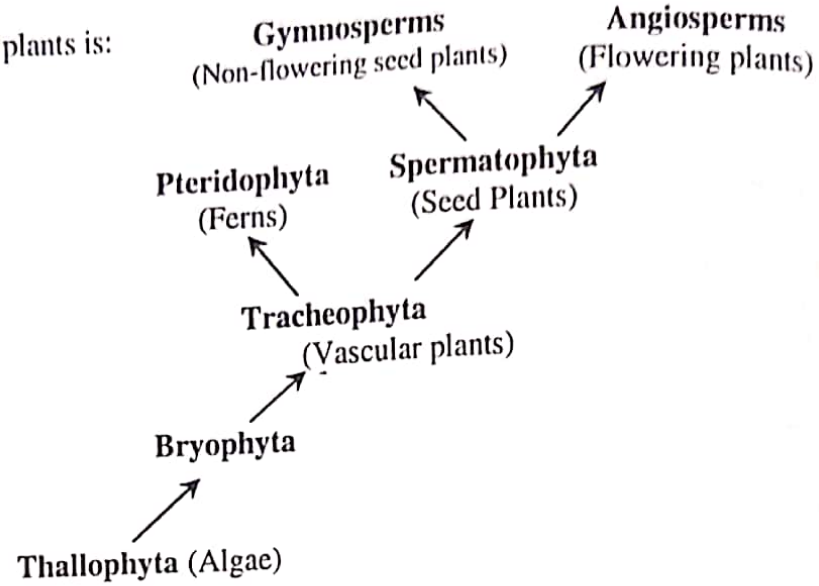
Cerebellum – Control of body posture as well as muscular movements, maintenance of body balance.
Pons varolii (pons) – It connects the lateral cerebellar hemispheres and contains centres for regulation of vital functions.
Medulla Oblongata – Regulation of mechanisms of respiration, heartbeat, digestion, blood pressure, breathing (i.e. homeastasis).
The pons and medulla contains fibres relaying impulses from the brain to periphery and vice versa.

Vision	-	Cerebrum
Walking	-	cerebrum and cerebellum
Digestion	-	brainstem (pons, medulla).
Breathing	-	brainstem (pons, medulla).

11. **D**
Herb may be annuals, biennials or perennials. Herbs may produce fruits just like shrubs and trees. However, unlike shrubs and trees, herbs do not become woody and thus do not become large in size (they have small biomass).

12. **A**

Evolutionary sequence in plants is:



The Mango plant is an angiosperm; Mosses (and Liverworts) are bryophytes; Spirogyra is a filamentous alga; ferns are pteridophytes while the Whistling Pine is a gymnosperm.

The correct order is:
Spirogyra → mosses → ferns → whistling pine → Mango plant
(i.e. (iii) → (ii) → (iv) → (v) → (i))

13 **C**

Oxygen diffuses across the alveoli of the lungs into the blood in the lung capillaries while carbon (IV) oxide diffuses out from the blood in the lung capillaries into the alveoli (opposite direction).
Excretion – Removal of waste or unwanted products
Osmosis – Movement of water molecules from a region of little or no solutes to a region of high solute concentration, across a semi-permeable membrane.
Transpiration – The loss of water from the leaf surfaces of plants. (Transpiration stream is the continuous flows of water from roots to leaves).

14. **A**

15. **B**

16. **D**

Producers are examples of autotrophs (organisms that utilize sunlight or chemical energy to manufacture their food from simple inorganic substances). Autotrophs include all green plants, photosynthetic protists and some bacteria (chemosynthetic bacteria).
Yeast and *Rhizopus* are fungi. *Spirogyra* is a plant (algae).

17. **D**

Feeding relationships in an ecosystem may be represented using:

- Pyramid of numbers
- Pyramid of biomass
- Pyramid of energy

Pyramid of numbers is used to represent the number of organism at each trophic (feeding) level. It may be upright (number of individual organism decrease progressively, while their sizes increase) or odd-shaped.
Pyramid of biomass represents the total wet or dry mass of the organism at each trophic. It gives a more accurate depiction of relationship between organisms. Most pyramids of biomass are upright; a few are odd-shaped.

Pyramid of Energy shows the rate of flow of food energy through each trophic level (i.e. how much of energy from the preceding trophic level flows to the next). All pyramids of energy are upright as energy is lost progressively from one trophic level to the other, usually as heat.
A **food chain** shows the transfer of food and energy from organism to organism in a linear feeding pathway. E.g. Grasses → antelope → lion → vulture (scavenger).
A **food web** is formed by the cross-linking of several food chains.

18. **B** – Both **temperature** and **rainfall** affect life in aquatic and terrestrial habitats. Relative humidity is not relevant in an aquatic habitat, while salinity and turbidity are not applicable to terrestrial habitats.

19. **D.**

20. **D** – (See 2007 Q. 13) A, B and C describe the **Theory of Natural Selection**, put forward by **Charles Darwin**. According to Charles Darwin:
   i. Organisms reproduce enormous numbers of offspring, much more than is expected to survive.
   ii. There is a continuous competition between individual organisms for food, water, oxygen, space etc. Thus there is continuous struggle for existence.
   iii. In this on-going struggle for existence, only those individuals better suited for life in their environment would survive (survival of the fittest). The individuals that are less suited to their environment die off or become extinct
   iv. All species exhibit structural and functional variation over many generations i.e. their forms and behaviour change with time.
   v. Variation that are advantages are inherited by subsequent generations.

   Option D applies to the theory put forward by **Jean Lamarck (Theory of use and Disuse)**

21. **B.**
Lungs and **spiracles** are used for **external respiration** in land vertebrates and insects respectively. **Scales** are modified **feathers** and they serve a **protective function**. The **contractile vacuole** is the "organ" of **osmoregulation** in protozoa, while the **kidney** performs a similar role in **vertebrates**.
Root hairs aid water and mineral absorption from the soil in plants. **Mammalian hairs** are for thermoregulation and protection.

The table below gives a summary of organs and their functions:

External Respiration

	Organism	Organ
1.	Earthworm	• • • n (the skin is moist)
2.	Fish	Gills
3.	Toad (adult)	Skin, buccal cavity, lungs (3 routes)
4.	Insects	Tracheal system (external openings are spiracles)
5.	Mammals	Lungs

Gaseous exchange in **plants** take place via the **stomata** (on leaves and green branches or stems), **lenticels** (on old stems and roots) and **root hairs** of young plants.
The **opening** and **closing** of the stomata is controlled by the **guard cells**. This in turn depends on the turgidity of the guard cells. For instance, in hot weather, water evaporates from the guard cells, causing them to become flaccid and close, thus minimizing water loss from the plant.

Excretion

	Organism(s)	Organ used
1.	Amoeba, Paramecium (Protists)	Contractive vacuole (excretory and osmoregulatory)
2.	Flat worms (e.g. *planaria*)	Flame cells
3.	Earthworm	Nephridia (sing. nephridium)
4.	Insects	Malpighian tubules
5.	Vertebrates	Kidneys

22. **C**

The evidence for evolution are:

- Comparative anatomy, morphology and vestigial structures
- Fossil records
- Biochemical similarities
- Molecular records (Genetics)
- Embryology

(NB: vestigial organs/parts in man include: appendix, rudimentary tail (coccyx), sparse body hairs, external ears. Vestigial parts in animals include the degenerated leg and pelvic bones in snakes, degenerated toe bones of horses. (the breasts are vestigial in male humans compared to females)).

23. The **variance** of a set of numbers (also known as the **mean squared deviation**) is defined as the arithmetic mean of the squares of all absolute deviations from the mean.

The procedures for calculating the variance for a set of numbers are outlined below:

STEP 1: Calculate the mean of the given numbers.

So for the numbers, K, K+1, K+2, the mean is calculated as follows:

$$\bar{x} = \frac{K + (K+1) + (K+2)}{3} = \frac{3K+3}{3} = \frac{3(K+1)}{3} = (K+1)$$

STEP 2: Find the absolute deviation of each number from the mean $(x - \bar{x})$, this is achieved by subtracting the mean from each of the numbers,

So, for deviation = $+1) = -1$

For , deviation = $-(K+1) = 0$

For , deviation = $-(K+1) = 1$

STEP 3: Find the sum of the squares of the deviations (that is, square each of the deviations and add up all the squares). This gives:

$$(-1)^2 + (0)^2 + (1)^2 = 1 + 0 + 1 = 2$$

STEP 4: Divide the result of STEP 3 by the amount of numbers given. In this case, it is 3. This gives:

$\frac{2}{3}$ ∴ The variance of the numbers , $K + 2$, is given as 2/3

A

NB: (i) the mean deviation is the arithmetic mean of all absolute deviations from the mean. For this problem, the mean deviation is the sum of the deviations (not squared), divided by 3,

i.e. $\frac{-1+0+1}{3} = \frac{0}{3} = 0$

(ii) **Standard deviation** (SD) = **square root of variance**. It is also referred to as the **root mean squared deviation.**

$SD = \sqrt{variance}$

24. Recall that standard deviation = $\sqrt{\text{var}\,iance}$

From the given information, standard deviation , this implies that the variance of the set of numbers is 6. We shall now go through the process outlined in 23 to calculate the variance.

Here it is:

$$\bar{x} = \frac{1 + (x+1) + (2x+1)}{3} = \frac{3x+3}{3} = \frac{3(x+1)}{3} = (x+1)$$

Therefore, the mean is: x + 1

$$Variance = \frac{[1-(x+1)]^2 + [(x+1)-(x+1)]^2 + [(2x+1)-(x+1)]^2}{3} = \frac{x^2+0^2+x^2}{3}$$

Recall that we found the variance = 6

Therefore, $\frac{2x^2}{3} = 6$

This implies that $x = \sqrt{\frac{6\times 3}{2}}\sqrt{9} = 3$ therefore x = 3

C

25. This is a problem of splitting a fraction into its constituent parts [PARTIAL FRACTION]
Solving the right hand side (RHS), we have:

$$\frac{m(x-4)+n(x+3)}{(x+3)(x-4)} = \frac{mx+nx-4m+3n}{(x+3)(x-4)}$$

The denominators of the RHS and LHS are the same; hence, the numerators must be the same for equality, thus,

$$mx+nx-4m+3n = x+7$$

Factorizing, gives:

$$x(m+n)-4m+3n = x+7$$

If $x = 0$,

$$0(m+n)-4m+3n = 0+7$$

$$3n-4m = 7 \quad \text{..... (I)}$$

If $x = 1$,

$$m+n-4m+3n = 1+7$$

$$4n+3m = 8 \quad \text{..... (II)}$$

We shall now solve (I) and (II) simultaneously, so we have:

$$3n-4m = 7$$

$$4n-3m = 8$$

Multiplying (I) by 4 and (II) by 3, gives

$$12n-16m = 28 \quad \text{..... (III)}$$

and

$$12n-9m = 24 \quad \text{..... (IV)}$$

Subtracting (IV) from (III), gives:

$$-7m = 4, \qquad \text{Thus, } m = \frac{-4}{7}$$

Substituting $m = \frac{-4}{7}$ in (I), gives:

$$3n-4\left(\frac{-4}{7}\right) = 7$$

$$3n+\frac{16}{7} = 7$$

$$3n = 7 - \frac{16}{7} \qquad = \frac{49-16}{7} = \frac{33}{7}$$

$$3n = \frac{33}{7} \qquad n = \frac{33}{7} \times \frac{1}{3} = \frac{11}{7}$$

Therefore, $m = \frac{-4}{7}$ *and* $n = \frac{11}{7}$

This implies that, $3n - 4m = 3\left(\frac{11}{7}\right) - 4\left(\frac{-4}{7}\right)$

$$= \frac{33}{7} + \frac{16}{7} = \frac{49}{7} = 7$$

A

26. $\sin(A+B) = \sin A\cos B + \cos A\sin B$ (Rule of trigonometry)

If $\sin A = \frac{3}{5}$, then from **trigonometric identities**: $\sin^2 A + \cos^2 A = 1$

Therefore, $\cos A = \sqrt{1 - \sin^2 A}$

$$\cos A = \sqrt{1 - \left(\frac{3}{5}\right)^2} \qquad = \sqrt{\frac{16}{25}} = \frac{4}{5}$$

Also, if $\cos B = \frac{5}{13}$

Using the identity: $\sin^2 B + \cos^2 B = 1$, we have that:

$$\sin B = \sqrt{1 - \cos^2 B}$$

$$\sin B = \sqrt{1 - \left(\frac{5}{13}\right)^2} = \sqrt{\frac{169-25}{169}} = \sqrt{\frac{144}{169}} \qquad = \frac{12}{13}$$

Collating the results we have so far, we have:

$$\sin A = \frac{3}{5},\ \cos A = \frac{4}{5},\ \cos B = \frac{5}{13}, \text{ and } \sin B = \frac{12}{13}$$

Therefore: $\sin(A+B) = \sin A\cos B + \cos A\sin B$

$$= \left(\frac{3}{5} \times \frac{5}{13}\right) + \left(\frac{4}{5} \times \frac{12}{13}\right) \qquad = \frac{15}{65} + \frac{48}{65} \qquad = \frac{63}{65}$$

D

Other forms of the trigonometric identities which are applicable to similar problems are:

$\sin(A-B) = \sin A\ \cos B + \cos A\ \sin B$

$\cos(A+B) = \cos A\ \cos B - \sin A\ \sin B$

$$\cos(A-B)=\sin A\sin B+\cos A\cos B$$

$$\tan(A+B)=\frac{\tan A+\tan B}{1-\tan A\tan B}$$

$$\tan(A-B)=\frac{\tan A-\tan B}{1+\tan A\tan B}$$

Note also that: $\tan(A\pm B)=\dfrac{\sin(A\pm B)}{\cos(A\pm B)}$

For more trigonometric identities and better understanding of trigonometry, attend a good tutorial outfit or get a good private mathematics tutor. This is because **MATHEMATICS, as well as FURTHER MATHEMATICS is now a fundamental part of UNIBEN Life Sciences Post-UTME EXAMS!**

27. From trigonometric ratios, we have the identity that:

$$\tan(A+B)=\frac{\tan A+\tan B}{1-\tan A\tan B}$$

$$\tan(x+45)=\frac{\tan x+\tan 45}{1-\tan x\tan 45}=2$$

But $\tan 45 = 1$,

So we have: $\dfrac{\tan x+1}{1-\tan x(1)}=2$

Cross multiplying, gives:

$$2(1-\tan x)=\tan x+1$$

$$2-2\tan x=\tan x+1$$

Collecting like terms, gives

$$3\tan x=1$$

$$\tan x=\frac{1}{3}$$

B

28. The fraction given has two linear factors in the denominator, hence, the partial fractions will be of the form:

$$\frac{A}{(x-2)}+\frac{B}{(x-3)}$$

Solving this, gives;

$$\frac{A(x-3)+B(x-2)}{(x-2)(x-3)}$$

Now, the denominator of the RHS is the same as that of the LHS, thus, the numerators must be the same for equality, that is,

$$A(x-3)+B(x-2)=5x-12$$

At $x=2$, we have:

$$A(2-3)+B(2-2)=5(2)-12$$

This gives $-A=-2, \quad A=2$

At $x=3$:

$$A(3-3)+B(3-2)=5(3)-12$$

$$B=15-12, \quad B=3$$

So, $A=2$ *and* $B=3$

Thus the partial fraction is of the form:

$$\frac{2}{(x-2)}+\frac{3}{(x-3)}$$

B

29. This is an **integration** problem; that of evaluating a definite integral. We shall proceed to obtain the result. However, you need to learn more on integration (and differentiation, i.e. calculus) and other topics in mathematics by attending tutorials or get a good private mathematics tutor.
Here is the solution for this problem:

$$\int_1^6 (2x+3)dx=\left[\frac{2x^{1+1}}{1+1}+\frac{3x^{0+1}}{0+1}\right]_1^6 \quad =\left[\frac{2x^2}{2}+\frac{3x^1}{1}\right]_1^6 \quad =\left[x^2+3x\right]_1^6$$

Now solving:

$$=\left(\frac{2(6)^2}{2}+3(6)\right)-\left(\frac{2(1)^2}{2}+3(1)\right)$$
$$=(36+18)-(1+3)$$
$$=54-4=50$$

B

30. This problem has to do with the application of **differentiation**. It is the concept of stationary or turning points.

Stationary points are points at which $\frac{dy}{dx}=0$

There are three types, namely: **minimum point, maximum point** and **point of inflexion.**

The **minimum point** is the point at which $\frac{d^2y}{dx^2}>0$

At the **maximum point,** $\frac{d^2y}{dx^2}<0$, while at the **point of inflexion,** $\frac{d^2y}{dx^2}=0$

To find the stationary point of a given function, the following methodology holds:

1. Find the derivative of the dependent variable with respect to the independent variable. e.g. If $y=x$, find $\frac{dy}{dx}$
2. Equate the expression from 1 to zero and obtain the values of the independent variable for which the derivative equals zero.
3. Find the second derivative, for this case $\frac{d^2y}{dx^2}$
4. Substitute the value(s) from (2) above into the expression in 3. The one that gives $\frac{d^2y}{dx^2}<0$ is the maximum point, the value from (2) that gives $\frac{d^2y}{dx^2}>0$ is the minimum point and the value that gives $\frac{d^2y}{dx^2}=0$ is the inflexion point

Now, let's solve the given problem. In this case, the given function is:

$$y = 4t^2 - 40t + 300$$

Differentiating the dependent variable (y) with respect to the independent variable, gives:

$$\frac{dy}{dt} = 8t - 40$$

Equating this to zero, gives

$$\frac{dy}{dt} = 8t - 40 = 0$$

$$8t - 40 = 0$$

$$8t = 40 \qquad t = \frac{40}{8} = 5$$

There is only one stationary point for this function and it has already been told to be a minimum point, but indeed,

$$\frac{d^2y}{dt^2} = 8 \quad > 0$$

This further proves the point as a minimum point. So the stationary or turning point of this function is t = 5 and the point is a minimum point.

The question seeks to determine the coordinate of the minimum point, thus, we shall substitute t = 5 in the given function to have the corresponding value of y: the pair of both is the required coordinate.
So at t = 5,

$$y = 4(5)^2 - 40(5) + 300$$

$$y = 100 - 200 + 300 = 200$$

At $t = 5, y = 200$
The coordinate of the minimum point is given as: (5,200).

B

31. $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$
1mol : 2mol
From the equation of reaction above, 1mol of $CaCO_3$ would require 2mol of HCl for a complete reaction yielding 1mol of CO_2. Thus, 0.0075mol of $CaCO_3$ will require two times this amount (2 × 0.0075) i.e. 0.0015mol of HCl, yielding 0.0075mol of CO_2.
NB: the numbers of mole of $CaCO_2$ used and CO_2 formed are the same (i.e. 1:1); therefore 0.0075mol of $CaCO_3$ would yield 0.0075mol of CO_2
From knowledge of Molar Gas Volume:
1 mole of any gas STP → $22.4dm^3$
∴ 0.0075 mole of CO_2 at STP → x

$$x = \frac{0.0075 \times 22.4}{1} = 0.168dm^3$$

But $1dm^3 = 1000cm^3$, therefore:
$0.168dm^3 = 0.168 \times 1000cm^3 = 168cm^3$

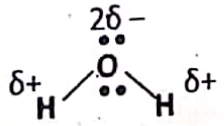
B

32. **B**
In carbohydrates the number of hydrogen atoms is twice that of oxygen.

33. **Electric dipole moment, P** is the product of one of the electric charges in a compoundnand the distance between the two charges.

$$\mathbf{P = Q \times d}$$

A **dipole** is made up of two charges of equal magnitude separated by a distance.
Let us look at a neutral water molecule as a dipole moment



The difference in electronegativities of the central oxygen atom and the 2 hydrogen atoms causes polarization (partial separation of charges) of the molecule. i.e. the hydrogen atoms acquire a partial positive charge each and to maintain electrical neutrality, the oxygen atom acquires 2 partial negative charges.

In summary, the dipole is written as:

$$2\delta- \longleftarrow \underset{d}{\longrightarrow} 2\delta+$$

Thus each charge is equal to 2e, where "e" is the charge on an **electron** or **proton**, which is 1.6×10^{-19}.

Thus Q = 2e

$= 2 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-19}$

From the formula: $P = Q \times d$

$$d = \frac{P}{Q} = \frac{6.2 \times 10^{-30}\, C.m}{3.2 \times 10^{-19}\, C} = 1.94 \times 10^{-11}$$

$= 0.19 \times 10^{-12} = 0.19$pm. (1 picometre = 10^{-12}m)

None of the options is correct!

34

$$\frac{m}{M_0} = \frac{c \times V}{1000}$$

m = mass, M_0 = molar mass, c = concentration (molarity), V = volume expressed in cm^3 or ml.

m = ?, $M_0 = 40$g/mol, c = 0.2M, V = $500cm^3$)

$$m = \frac{c\ V\ M_0}{1000} = \frac{0.2 \times 500 \times 40}{1000} = 4\text{g}.$$

C

35. $2NH_4Cl + Ca(CO)_2 \rightarrow 2NH_3 + CaCl_2 + 2H_2O$

2mol 1mol

(NH_4Cl = 53.5g/mol, $Ca(OH)_2$ = 74g/mol)

2moles of NH_4Cl are decomposed by 1mol of $Ca(OH)_2$. This implies that:

2×53.5g (2mol) of NH_4Cl is decomposed by 74g of $Ca(OH)_2$

107g of NH_4Cl : 74g of $Ca(OH)_2$

$\therefore$ 50 of NH_4Cl = xg of $Ca(OH)_2$?

$$x = \frac{50 \times 74}{107} = 34.58\text{g}$$

B

36. Using the formula for Faraday's First Law of Electrolysis:

$$m = \frac{RAM \times I \times t}{q \times F}$$ (See 2006, Q.3)

RAM = 51, m = 1.2g, I = ?, t (time in seconds) = 1× 60 × 60 = 3600s, q = 3 (i.e. Chromium III, Cr^{3+}), F = 9600C

Making "I" the subject of the formula and substituting:

$$I = \frac{m \times q \times F}{RAM \times t}$$

$$I = \frac{1.2 \times 3 \times 9600}{51 \times 3600} = 1.892 \approx 1.89\text{A}$$

C

37. The **torque** of a dipole is given by:

τ = Force × distance (perpendicular)

$\tau = QEd\sin\theta$

But $\vec{P} = Q \times d$, thus:

$$\tau = \vec{P} \times \vec{E} \sin\theta$$

At a value of $\theta = 90^{o}$, τ will have a maximum value.

B

38. All **potentials** are scalars.

A

39. Work done = Electric Force × distance

Based on the parameters provided, electrostatic force, F = qE
Where: q = charge on electron = -1.6×10^{-19}C, E = electric field = 150N/C, d = displacement = 520m
Therefore, from W = F × d (where F = qE)

$$W = qE \times d$$
$$= -1.6 \times 10^{-19} \times 150 \times 520$$
$$= -1.24 \times 10^{-14} \text{ J}$$

[charge on an electron = -1.6×10^{-19}]

A

40. **B** – World wide web

41. **C** – In December 2010, China unveiled the world's fastest train. The train is said to travel faster than the helicopter. Japan however is developing a train that would run faster and thus break China's record.

42. **C** – Abdulsalami Abubakar. (See a current affairs booklet for more information).