1. Chalk is composed of calcium carbonate, $CaCO_3$. This water-insoluble compound is formed when a solution of calcium chloride is added to a solution of sodium carbonate. How many milliliters of 0.25 M calcium chloride are needed to react completely with 50 mL of 0.15 M Na_2CO_3 solution?
   A. 10
   B. 15
   C. 30
   D. 60

2. Zeolite as a porous material is often used as catalyst. Which of the following statements are CORRECT concerning catalyst.
   (1) Catalyst increases the equilibrium constant of the reaction.
   (2) Catalyst decreases the activation energy of the reaction.
   (3) Catalyst is not involved in the reaction.
   (4) Catalyst increases the rate of reaction.
   A. (1) and (2)
   B. (2) and (4)
   C. (3) and (4)
   D. (1) and (4)

3. An electron moves up from K (n=1) shell to M (n=3) shell. The correct statement concerning the phenomenon is ...
   A. electron absorbs energy equal to shell energy M minus shell energy K
   B. electron absorbs energy equal to shell energy K minus shell energy M
   C. electron emits energy equal to shell energy M minus shell energy K
   D. electron emits energy equal to shell energy K minus shell energy M

4. Bioethanol (C_2H_5OH) can be used as alternative fuel in accordance with the following combustion reaction:
   $$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O + Energy$$
   If 13.8 g bioethanol is burnt with 19.2 g O_2, the volume of CO_2 gas emitted to the air when it is measured at standard condition (STP) is ... (A_r C=12, O=16, H=1)
   A. 8.96 L
   B. 13.4 L
   C. 17.9 L
   D. 6.72 L

5. An indicator, HIn has an ionization constant, $K_a = 1 \times 10^{-5}$. If the aqueous solution containing non-dissociated molecular form (HIn) of the indicator has yellow color and the solution of In^- ion is green, what would be the color of the solution of this indicator when its pH is 3.0?
   A. yellow
   B. green
   C. pale yellow
   D. pale green

6. Arrange in order of increasing energy for removing an electron from $_{19}K^+$, $_{18}Ar$ and $_{17}Cl^-$
   A. $K^+ < Ar < Cl^-$
   B. $Ar < Cl^- < K^+$
   C. $Cl^- < K^+ < Ar$
   D. $Cl^- < Ar < K^+$

7. A 0.244 g sample of a diprotic acid requires 40.0 mL of 0.100 M of KOH for complete neutralization. The molecular mass of the acid is ...
   A. 244 g/mol
   B. 122 g/mol
   C. 61 g/mol
   D. 488 g/mol

8. A very effective anesthetic, cyclopropane, contains the elements carbon and hydrogen combined in a ratio of 1.0 g of hydrogen and 6.0 g of carbon. If a given sample of cyclopropane was found to contain 30.0 g of hydrogen, how many grams of carbon would it contain?
   A. 5
   B. 54
   C. 180
   D. 864

9. One of the major environmental concerns is the phenomenon of acid rain. Rain water in an unpolluted atmosphere will be ...

   A. neutral
   B. slightly basic
   C. slightly acidic
   D. strongly acidic

10. The pH of the solution of 5×10^{-8} M HCl at 25°C is ....

   A. 6.3
   B. 6.9
   C. 7.3
   D. 7.9

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11. During an earthquake, a heavy object can sink into the ground if the shaking causes the ground to undergo liquefaction and the soil grains experience little friction as they slide over one another. The possibility of liquefaction in sandy ground can be predicted in terms of the *void ratio e* for a sample of the ground given by

$$e = \frac{V_{voids}}{V_{grains}}.$$

Here, V_{grains} is the total volume of the sand grains in the sample and V_{voids} is the total volume between the grains (in the *voids*). If *e* exceeds a critical value of 0.650, liquefaction can occur during an earthquake. If the primary component of the sand mainly originates from solid *silicon dioxide* (SiO_2) with a density $\rho_{SiO_2} = 2.60 \times 10^3$ kg/m³, what is the corresponding sand density, ρ_{sand}, at the critical point ?
   A. 1.58×10^3 kg/m³
   B. 1.69×10^3 kg/m³
   C. 2.43×10^3 kg/m³
   D. 4.00×10^3 kg/m³

12. Indonesia is one of the countries in Asia that is located on the equator. Suppose you were lying on a beach close to the equator watching the sunset over a calm ocean. Then you start a stopwatch just after the top of the Sun disappears. Next, you immediately stand up, elevating your eyes of a height $H = 1.70$ m, and stop the stopwatch when the top of the Sun again disappears. If the elapsed time is $\Delta t = 11.1$ s and by assuming that the shape of the Earth is round, estimate the radius *r* of Earth based on your observation?
   A. 4.83×10^6 m
   B. 5.30×10^6 m
   C. 6.61×10^6 m
   D. 7.20×10^6 m

Consider two capacitors which are connected in series by the movable rigid center section made from metal of length b shown in the following Figure.
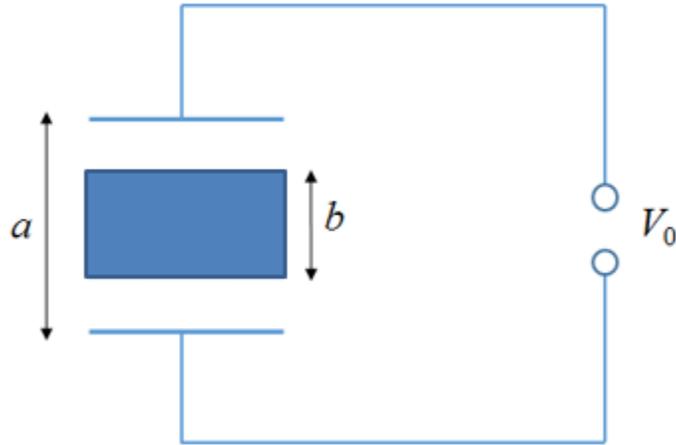
Capacitors constructed by using movable rigid center section

The area of each plate is A. If the voltage difference between the outside plates is kept constant at V0, what is the change in the energy stored in the capacitors if the center section is removed?

A. $\dfrac{\varepsilon_0 A V_0}{2(a-b)}\left(\dfrac{a}{b}\right)$

B. $\dfrac{\varepsilon_0 A V_0}{2(a-b)}\left(\dfrac{b}{a}\right)^2$

C. $\dfrac{\varepsilon_0 A V_0^2}{2(a-b)^2}\left(\dfrac{b}{a}\right)^2$

D. $\dfrac{\varepsilon_0 A V_0^2}{2(a-b)}\left(\dfrac{b}{a}\right)$

14. An electronic device has been poorly designed so that two bolts attached to different parts of the device almost touch each other in its interior, as shown in the following Figure.
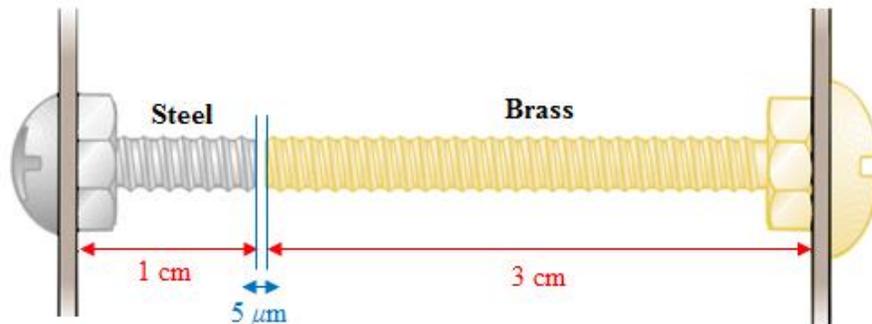
Electronic device which consists of two different structures is shown

The steel and brass bolts are at different electric potentials and if they touch, a short circuit will develop, damaging the device. If the initial gap between the ends of the bolts is 5.00 μm at 27.0°C, at what temperature will the bolts touch? Thermal expansion coefficient for brass and steel are 19.0×10^{-6}/°C and 11.0×10^{-6}/°C, respectively.

A. 34.4 °C
B. 36.6 °C
C. 42.9 °C
D. 46.2 °C

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15. A floating iceberg in seawater, as shown in the Figure below, is extremely dangerous because most of the ice is below the surface.

This hidden ice could damage a ship that is still a considerable distance from the visible ice. Estimate what fraction of the iceberg lies below the water level if the density of seawater is 1030 kg/m^3 and the density of iceberg is 917 kg/m^3.

A. 0.352
B. 0.756
C. 0.781
D. 0.890

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16. A civil engineer wishes to design a curved exit ramp for a highway in such a way that a car will not have to rely on friction to round the curve without skidding. In other words, a car moving at the designated speed can negotiate the curve even when the road is covered with ice. Such a ramp is usually banked; this means that the roadway is tilted toward the inside of the curve with the angle θ shown in the following Figure.
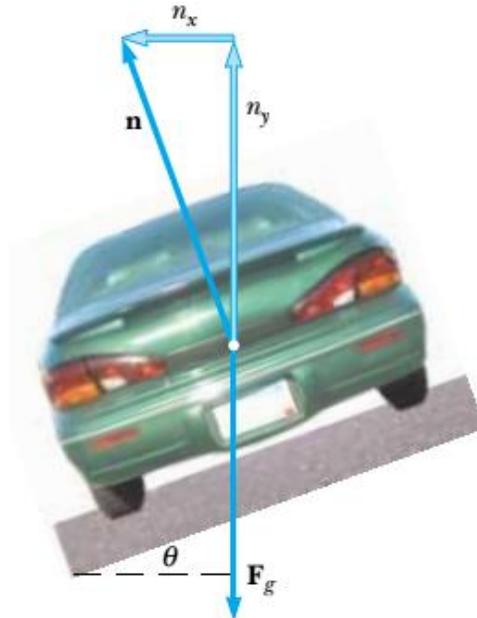
Schematic design of a curve exit ramp for highway

Suppose the designated speed for the ramp is 13.4 m/s and the radius of the curve is 50.0 m, at what angle θ should the curve be banked? (Acceleration due gravity equals 9.80 m/s^2)
A. 13.5^0
B. 17.9^0
C. 20.1^0
D. 28.3^0

17. You are designing an apparatus to support an actor of mass 65 kg who is swinging over the stage during the performance of a play. You attach the actor's harness to a 130-kg sandbag by means of a lightweight steel cable running smoothly over two frictionless pulleys as shown in the following Figure.
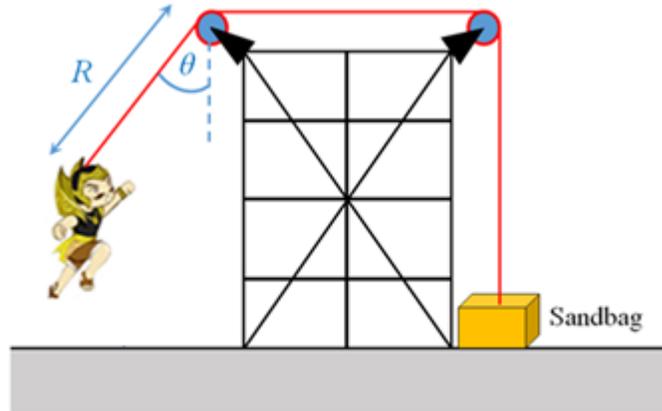

Schematic view of an apparatus used by an actor to fly down to the stage during the performance of a play.

You need 3 m cable between the harness and the nearest pulley so that the pulley can be hidden behind a curtain. For the apparatus to work successfully, the sandbag must never lift above the floor as the actor swings from above the stage to the floor. The initial angle that the actor's cable makes with the vertical θ. What is the maximum value θ can have before the sandbag lifts off the floor? (assume that the actor can be viewed as a point particle).

A. 30^0
B. 40^0
C. 60^0
D. 90^0

18. Two large horizontal metal plates are a distance d apart. These plates are maintained at a potential difference V where the lower plate being positive as shown in the following Figure.
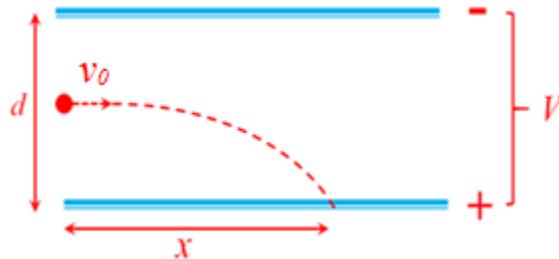

Schematic view of a beams electron motion under an electric field induced by two plates

A beam of electrons (with charges $-e$ and mass m) is introduced midway between the plates moving parallel to them at speed of v_0. At what horizontal distance x will the beam hit the positive plate? (The Gravitational force is ignored)

A. $\dfrac{v_0^2 dm}{2eV}$

B. $\dfrac{v_0 eV}{2dm}$

C. $v_0 d\sqrt{\dfrac{m}{eV}}$

D. $v_o^2 d\sqrt{\dfrac{eV}{m}}$

19. A metal wire of mass m slides without friction on two rails spaced of distance d apart, as shown in the Figure below. The track lies in a vertical uniform magnetic field **B**.
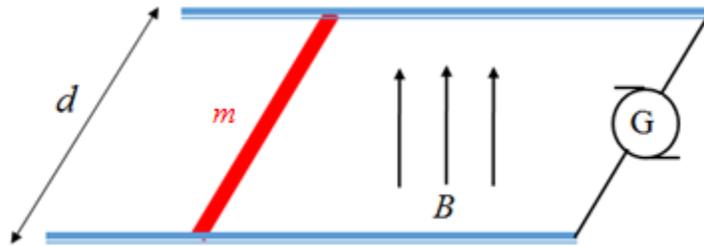

A metal wire slides without friction on two rails under homogenous magnetic fields

A constant current I flows through generator G along one rail, across the wire, and back down the other rail. Assume that at $t = 0$, the wire is initially at rest. Which ones the following figures is correct for the velocity v_t as a function of time t?

A.

B.

C.

D.
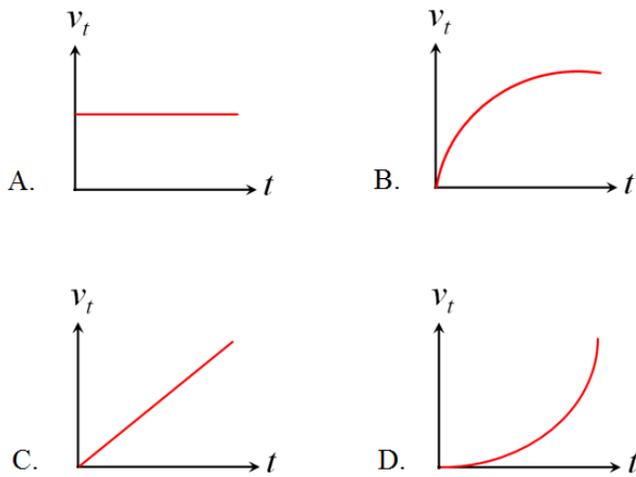
20. A light source device located on point **A** produces an incident light which is reflected by a mirror with the configuration as shown in the following Figure.
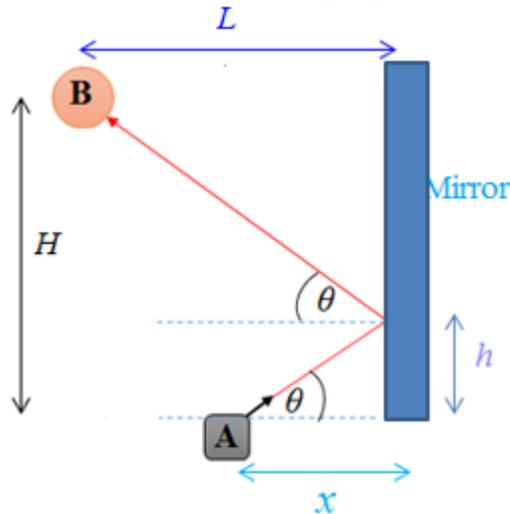
Schematic view of a light path from point A to point B

An object which is located on the point **B** is aimed to be a target of the reflected light. If the horizontal distance of the object in the point **B** to the mirror is 2.20 m, the vertical distance between **A** and **B** (H), and between **A** and the point of reflection (h) are 1.68 m and 0.430 m respectively, find the horizontal distance (x) between the light source device (**A**) and the mirror.

A. 0.381 m
B. 0.757 m
C. 1.04 m
D. 1.42 m

21. Female silkworm moths (*Bombyx mori*) attract males by emitting chemical signals that spread through the air. A male hundreds of meters away can detect these molecules by chemoreceptors and can fly toward their source. A chemoreceptor is a sensory receptor that detects chemical stimuli. The sensory organs responsible for this behavior are the comb like antennae. Each filament of an antennae is equipped with thousands of receptor cells that detect the sex attractant. The correct proposed hypothesis to account for the ability of the male moth to find the female: The chemoreceptor at the antenna of the male moth .....
A. is only specific for detecting the chemical compound emitted from the female moth within certain distances. The male moth finds the female moth piloted by specific chemical compound which is emitted by the female moth.
B. is not specific for detecting the chemical compound emitted from the female moth within certain distances.
C. can detect all chemical compounds in the air but the male moth finds the female moth by chance.

D. can detect all chemical compounds in the air including specific chemical compound emitted from the female moth which guides the male to the female.

22. Pathogenicity of *Bacillus thuringiensis* (*Bt*) ORG1 isolate against instar 3 larvae of *Spodoptera litura* was determined by Probit Analysis. The LC50 is known as the concentration of bacterial cells that kills 50% (probit mortality = 5) of *Spodoptera litura* larvae. The probit analysis on Bt ORG1 isolate using the regression line $Y = 2.8279 + 0.2069X$ results in the LC50 during 24 hours = 3.15×10^{10} cell/mL. We tested another *Bt* isolate (*Bt* ORG2) for pathogenicity against towards *Spodoptera litura* larvae and obtained a probit regression line with slope of 0.5245 and LC50 during 24 hours = 2.15×10^{10} cell/mL. Based on the value of LC50 and the slope of probit regression line, which *Bt* isolate is more pathogenic?
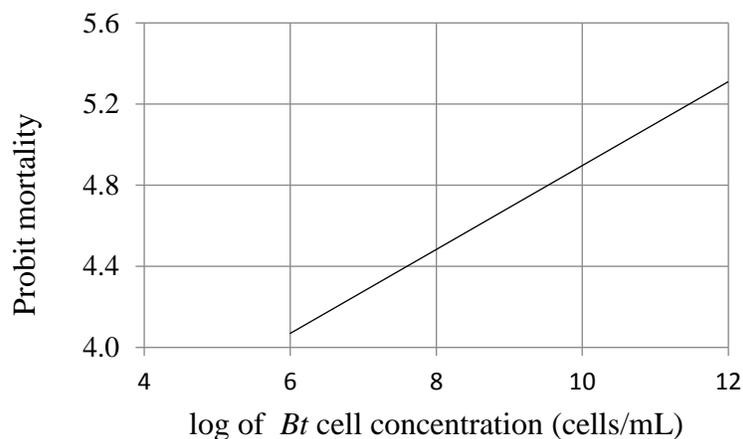

Probit regression line, $Y = 2.8279 + 0.2069X$, bioassay *Bt* isolate ORG 1 against 3th instar larvae of *Spodoptera litura*

A. *Bt* ORG1 isolate
B. *Bt* ORG2 isolate
C. *Bt* ORG1 is as pathogenic as *Bt* ORG2
D. Neither *Bt* isolate ORG1 nor *Bt* isolate ORG2 is pathogenic

23. Which of the following statements is INCORRECT about a prokaryote? It has …..
A. nucleoid, a region where the cell's DNA is located (not enclosed by a membrane)
B. fimbriae-attachment structures on the surface of some prokaryotes
C. plasma membrane enclosing the cytoplasm
D. centrosome, a region where the cell's microtubules are initiated; contains a pair of centrioles

24. Hemoglobin, the oxygen-binding protein of red blood cells, is also a globular protein with quaternary structure. The quaternary structure of hemoglobin is figured out as four polypeptide sub-units, consisting of two α sub-units and two β sub-units. Both α and β sub-units primarily have α-helical secondary structure. Each sub-unit has a non-polypeptide component, called heme, in which an ion of iron binds oxygen. Which of the following figure represents the structure of hemoglobin?

A   B   C   D
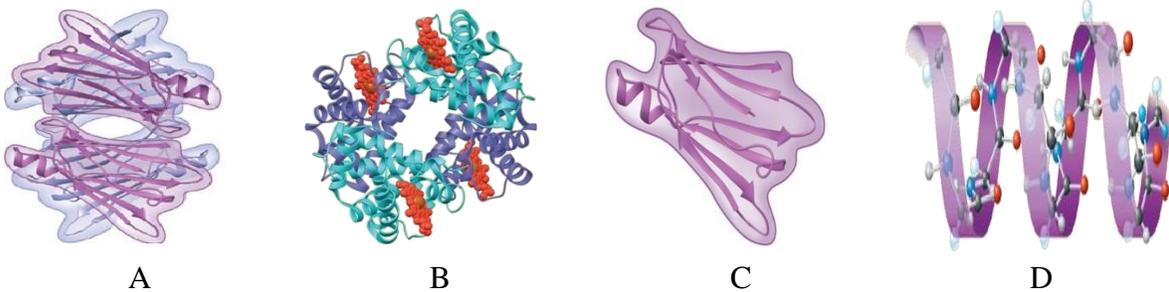
25. The following figure shows a cross section of the root of *Ranunculus* (buttercup) describing the organization of primary tissues in young roots. This root cross section represents basic pattern of root organization. What is the name of the root tissue indicated by the question mark?
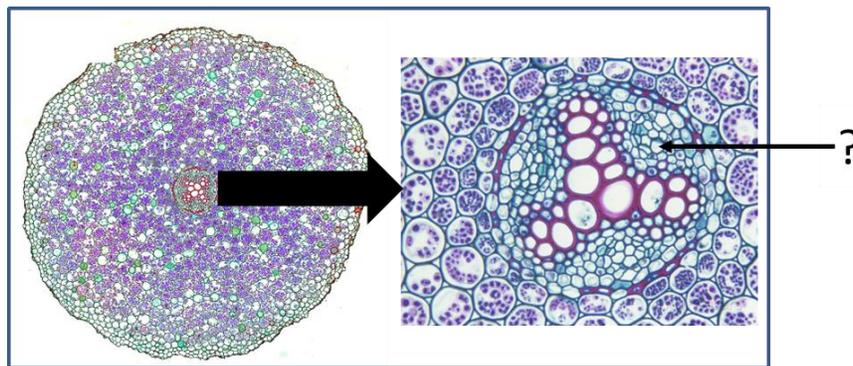
Cross section of the root of *Ranunculus* (buttercup).

A. Phloem
B. Cortex
C. Xylem
D. Endodermis

26. Malaria is a disease caused by plasmodium. The plasmodium spreads from an individual to the others by a mosquito vector. A vector species of plasmodium-carrying mosquito lives in a forest together with two different species of monkeys, X and Y. Species X is immune to plasmodium, but species Y is not. That plasmodium-carrying mosquito is a food source for a particular bird in the forest. If all the birds were suddenly eliminated by hunters, which of the following statements would be an immediate observable consequence?
   A. Increased mortality (death rate) in species X
   B. Increased mortality in species Y
   C. Increased mortality in the plasmodium-carrying mosquitoes
   D. No increased mortality in both species X and Y

27. Certain species of acacia trees in Baluran National Park, East Java, Indonesia have hollow thorns inhabited (resided) by stinging ants which attack anything that touches the tree. The ants get nutrients produced by the acacia. This is an example of the interaction called…...
   A. Mutualism
   B. Parasitism
   C. Competitive exclusion
   D. Intraspecific competition

28. Human has dozens of antigens on the surface of his/her blood cells. One group of antigens, designated as the MN blood group, stimulates the production of antibodies when injected into rabbit. Allele for MN blood groups, usually designated as M and N, are codominant. It means that Genotype MM produces only antigen M, while genotype NN produces only antigen N, and the heterozygous genotype MN produces both antigens. Given the following data:

Genotype	Observed
MM	320
MN	480
NN	200
Total	1000

What is the frequency of allele M?
   A. 0.44
   B. 0.56
   C. 0.32
   D. 0.16

29. Sexual reproduction in plants and animals involve the union of two gametes to form a single cell called zygote. Gametes include the egg and sperm cells. Zygote is formed after the sperm fertilizesthe egg, resulting in diploid chromosome. The zygote develops into ... .
(Hint: The following figure indicates fertilized egg)

Diploid (2n)
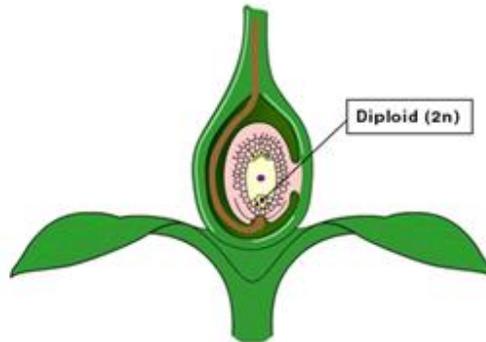
    A. Embryo
    B. Endosperm
    C. Carpel
    D. Ovule

30. Photosynthesis consists of two processes, with each process involves multiple steps. These two photosynthesis processes are known as: (i) the light reactions as the first stage of photosynthesis that uses sunlight as an energy source absorbed by chlorophyll and (ii) the Calvin cycle as the second stage that can proceed without sunlight. Which of the following is INCORRECT statement about photosynthesis?
    A. It is a combination of the light reactions and the Calvin cycle. In the chloroplast, the thylakoid membranes are the sites of the light reactions, whereas the Calvin cycle occurs in the stroma
    B. The light reactions also generate ATP, using chemiosmosis to power the addition of a phosphate group to ADP, a process called photophosphorylation
    C. The light reactions use solar energy to make ATP and NADPH, which supply chemical energy and reducing power, respectively, to the Calvin cycle
    D. The Calvin cycle releases CO_2 from organic molecules, which are converted to sugar.