**Time : 3 hrs Marks : 30**

# Multiple Choice Questions

1 ) Answer : A **Solution :** a: 27m3 / 22.4 lt = 10^3 moles = 10^26 molecules

b: 1000/18 = 50 moles = 10^25 atoms

c: 5 seconds for 1 breath => 10^8 breaths

d: 14 billion years => 10^17 seconds

2 ) Answer : A **Solution: The sun is just below the horizon. The Moon is just above the horizon. This implies crescent moon. Since the illumination is from below, answer is A.**

3 ) Answer: B Solution :

$$m = \frac{\sin i}{\sin r}$$

$$\sin r = \frac{\sin i}{m} = \frac{R/\sqrt{1+(3/4)^2}R}{\frac{4}{3}} = \frac{3}{5},$$

$$\cot r = \frac{4}{3} = \frac{R}{R' - R}$$

$$R' = \frac{7}{4}R$$

Area of shadow = $\frac{49}{16}\pi R^2$

4 ) Answer B**. Solution:** The magnetic field above the wire is out of the plane. This flux is decreasing and should be compensated by the current in the loop F and so the current in loop F will be anti- clockwise. For loop G the situation is opposite

5 ) Answer A**: Solution : (a) corresponds to p = 0. Then solve for T and put V = 1, a = α, b = β**

6 ) Answer C

7 ) Answer B

8 ) Answer B: **Solution :** We assume the sign convention where distance measured in the direction of light propagation are positive, and in opposite direction, negative. For the morning experiment, since the image of the outside world (object distance $u \approx$ inf) is real, sharp and

inverted, the lens must be converging one, and the image distance ($v$) is equal to the focal length ($f$) of the lens. Thus $f$ = 0.120m. for the evening experiment, the hole in the card serves as the object of size 0.005m. The image size on the wall is 0.020m.

- Distance between the lens and the card $u = -uc$ ($uc > 0$)
- Distance between the lens and the wall $v = +vc$ ($vc > 0$)
- Distance between the lens and wall (question) $d = uc + vc$
- Magnification = $vc/-uc$ = 0.020 / -0.005 = -4 (real images by converging lenses always have negative magnification, i., inverted image).

Thus, applying the lens formula

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$

$$\frac{1}{vc}+\frac{1}{uc}=\frac{1}{f}$$

$$\frac{1}{4uc}+\frac{1}{uc}=\frac{1}{f}$$

$$\frac{5}{4uc}=\frac{1}{f}$$

$uc$ =5$f$ / 4 = 5 x 0.120m/4 = 0.150m

$vc$ = 4 $uc$ – 4 x 0.150m = 0.600m

Therefore, the distance between the lens and the wall is

$d = uc + vc$ = (0.15 0 + 0.600)m = **0.750m**

# Multiple Choice Questions

**9** ) Answer D **:Solution:**

$V_1 = 300$ V $\quad t_1 = 5$ min

$V_2 = 200$ V $\quad t_2 = 20$ min

$V_3 = 100$ V $\quad t_3 =$ ? min

Rate of heat supplied by heating container = $\frac{V^2}{R}$

For first and second container (resistance $R$ is same)

$$\frac{t_1}{t_2} = \frac{1}{4} \neq \frac{V_1^2}{V_2^2} = \frac{4}{9}$$

Second container should take 2.25 times that of container one but it is taking four times that of container one. There is some heat loss ( $P_{loss}$ ) to the environment which is at lower temperature than ice temperature ( $0^0$ C).

Same amount of heat is being melt in both containers, that means amount of heat supplied is same.

$$\left(\frac{V_1^2}{R} - P_{loss}\right)t_1 = \left(\frac{V_2^2}{R} - P_{loss}\right)t_2$$

which gives $P_{loss} R = \frac{5}{3} \times 10^4 = V_{loss}^2 > V_3^2 = 10^4$ .

Container will loose all heat given by 100 V power supply and ice will cool down instead of melting.

**Additional:**

Say outside temp is $T_0$ and final temperature of ice is $T_f$ .

$$k(0 - T_0) = 10^4 \times \frac{5}{3}$$

$$k(T_f - T_0) = 10^4 \times 1$$

which gives $T_f = \frac{2}{3} T_0$

# Multiple Choice Questions

10 ) Answer C:
Force at the bottom : $F_b$
Weight of water : W
Downward vertical force of curved surface on water is : $F_g$

Then $F_b = W + F_g$
=> $F_g = F_b - W$
=> $P_b.A - V\rho g$
$F_g = \rho g h A - V\rho g$
$F_g = \rho g (hA - V)$
$= 10^3 \times 10 \times [0.25 \times 3.14 \times (0.20)^2/4 - 2.5 \times 10^{-3}]$ N

$= 10^4 \times [7.85 - 2.50] \times 10^{-3}$ N
$= 53.5$ N
By 3rd law, $F_g$ = vertical force of water on glass

11 ) Answer **B : Fig 2 violates Pauli's exclusion principle and Hund's rule.**

12 ) Answer C: **Solution :** Grahams law of diffusion

$$\frac{r_{HCl}}{r_{NH_3}} = \sqrt{\frac{m_{NH_3}}{m_{HCl}}} \text{ or } = \sqrt{\frac{17}{36.5}}$$

13 ) Answer A : **Frendlich isotherms: (lower the temp higher is the adsorption)**

14 ) Answer C: **Solution :** The conductivity that is measured in an electrolyte solution depends on the type and concentration of the ions. As long as the reaction is taking its course the conductivity drops, when the standard solution is in surplus the conductivity rises again

15 ) Answer D: **Statements (i) and (iii) are correct**

16 ) Answer B:

17 ) Answer B: **Iron acts as the cathode and oxygen is reduced.**

18 ) Answer A: **A) I and III are correct**

19 ) Answer D: Solution:

$[Pb^{+2}] = 1 \times 10^{-3}$

$[Br^-] = 5 \times 10^{-4}$

Ionic product = $[Pb^{+2}]\ [2Br^-]^2$

Ionic product = $[1 \times 10^{-3}]\ [2x5 \times 10^{-4}]^2$

$10^{-3+2-8}$

$10^{-9}$ As $K_{sp}$ > ionic product, **no precipitate will form.**

20 ) Answer D: **each of the molecules is planar and triangular.**

21 )Answer A: **Solution:** T is present only in DNA, while U is present only in RNA. If A≠T or U it is single stranded. If A = T it is most likely to be double stranded. Sample 1 could possibly be single stranded. However, it is not one of the choices in the correct answer (A).

22 ) Answer B: **B) (i), (iv) and (v)**

**Solution:**

- If trait is dominant then daughter would show the trait as it would inherit the father's X-chromosome. Since son shows the trait, X chromosome inherited from the mother carried the recessive trait (carrier).
- As the daughter would inherit the father's X-chromosome the daughter is bound to be a carrier.
- As the trait is RARE, marriage outside the family ensures that the mother is likely to not carry the trait. Hence the son will have '0' probability of inheriting the trait as the X-chromosome will come from the mother.

23 ) Answer B: **(i) and (z); (ii) and (y); (iii) and (x)**

**Solution:** It based on analysis. No prior knowledge is needed.

- In case of 'x' level of $T_3$ and $T_4$ will be low. As $T_3$ and $T_4$ has a negative effect on TRH levels, there will be an increase in the levels of TR . Thus 'x' matches with 'iii'
- In case of 'y' $T_3$ and $T_4$ is low, so TRH levels are high (as explained above). As TRH positively regulates TSH, TSH levels will increase. Thus 'y' matches with 'ii'

## Multiple Choice Questions

- In case of ‘z’ TRH levels are low, thus TSH levels will be low and finally $T_3$ and $T_4$ levels will be low. Thus ‘z’ matches with ‘i’.

24 ) Answer C: **C) 1/16**

**Solution:** $^{14}N$: $^{15}N$ (start); after 1 cycle two molecules of DNA, $^{14}N$: $^{15}N$ and $^{14}N$: $^{14}N$; after 2 cycle four molecules of DNA, one $^{14}N$: $^{15}N$ and three $^{14}N$: $^{14}N$; after 3rd cycle we will have 8 molecules of DNA, one $^{14}N$: $^{15}N$ and rest 7 $^{14}N$: $^{14}N$. Finally after the 4th cycle there will be 16 molecules of DNA of which only one will be hybrid $^{14}N$: $^{15}N$ in nature.

25 ) Answer B:

**B) Cacti close their stomata during the day, so availability of $CO_2$ for RuBP carboxylase activity is low during the day.**

**Solution:** To conserve water during the hot days, cacti close stomata during the day. This reduces the $CO_2$ concentration in the leaf, which cannot support RuBPcase activity.

26 ) Answer D: **D) i and iv**

**Solution:** ‘i’ has equal illumination so the seedling does not bend. In ‘iv’ the seedling bends towards the higher illumination.

27 ) Answer C: **C) These organelles have their own genetic material.**
**Solution:** A and C are correct but only C supports the concept of endosymbiosis. B is possible only for a short duration.

28 ) Answer C: **C) T-cells, antibodies and HIV**

29 )Answer A**: Solution:** Population increase under these ideal conditions is called exponential population growth, giving rise to what is called a J-shaped growth curve. Curve presented in D is based on logistic model of population growth. B and C are just created as wrong answers.

**Comment: Typical growth-curves for populations is a topic mentioned in the syllabus under Systems – Ecology. See Chapter on Population Ecology in Biology 7th Edition, Campbell and Reece for clarification on growth curves.**

30 )Answer B: **B) Ammonia in tadpole and urea in frog.**

**Solution:** As ammonia has maximum solubility in water, thus tadpole has evolved the mechanism to generate ammonia as the waste. On the other hand a land animal would generate urea or uric acid. Frog makes urea.