香 港 資 優 教 育 學 苑
The Hong Kong Academy for Gifted Education

International Junior Science Olympiad 2022 – Hong Kong Screening

Question Book

Rules and Regulations:

1. The contest is a 1-hour written test.

2. The paper consists of 45 multiple-choice questions.

3. Point rules:
   Full mark: 45 points
   For each question:
   - correct answer: $+1$ point
   - wrong answer: $-\frac{1}{3}$ point
   - no answer: 0 point

4. Questions are in bilingual version.

5. Put your answers on the MC Answer Sheet.

6. Mark only ONE answer for each question. If more than one answer is marked, it will be regarded as a wrong answer. Please choose the BEST answer.

7. Only calculators approved by The Hong Kong Examinations and Assessment Authority with “HKEAA APPROVED” logo can be used for the contest. Measuring instruments like rulers and compasses may also be used. No stationeries will be provided.

Co-organised by Education Bureau, The Hong Kong Academy for Gifted Education,
and The Hong Kong Association for Science and Mathematics Education

香港資優教育學苑
The Hong Kong Academy for Gifted Education

國際初中科學奧林匹克 2022–香港選拔賽

問題簿

學生守則：

1. 比賽以筆試形式進行，限時一小時。

2. 本試卷共有 45 題多項選擇題。

3. 評分制度:
   全卷： 45 分
   每條題目：
   - 答對：+1 分
   - 答錯：$-\frac{1}{3}$ 分
   - 沒有作答：0 分

4. 題目中英對照。

5. 請把答案填劃在多項選擇題答題紙上適當的位置。

6. 每題只可填劃一個答案。若填劃多個答案，則該題將被視作答錯。請選擇最適當的答案。

7. 比賽時，學生只可使用香港考試及評核局認可型號、並印有 “HKEAA APPROVED” 的計算機。直尺、圓規及其它量度工具亦可作輔助之用。大會不提供任何文具。

PERIODIC TABLE 周期表

GROUP 族

atomic number 原子序

1
H
1.0

relative atomic mass 相對原子質量

I	II											III	IV	V	VI	VII	0
																	2 He 4.0
3 Li 6.9	4 Be 9.0											5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0	10 Ne 20.2
11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 40.0
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 * La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 ** Ac (227)	104 Rf (261)	105 Db (262)													

*	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
**	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

List of formulae and relationships which may be useful
可能有用的公式和關係式

Linear motion with constant acceleration
直線均加速運動

$v = u + at$, $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$.

Kinetic energy 動能 $= \frac{1}{2}mv^2$

Potential energy 潛能 $= mgh$

Force 力：$F = ma$

Electrical resistance 電阻
$R = V/I$
$R = R_1 + R_2$ in series 串聯
$1/R = 1/R_1 + 1/R_2$ in parallel 並聯

Electrical power 電功率：$P = IV = V^2/R = I^2R$

Centripetal acceleration 向心加速度: $\frac{v^2}{r}$

Law of universal gravitation 萬有引力定理 $F = Gm_1m_2/r^2$

Multiple Choice Questions (45 marks)

1. A coin is falling vertically downward with a constant speed in a liquid. Which of the following statements about the motion is correct?

   A. The acceleration of the coin remains unchanged.
   B. The acceleration of the coin increases.
   C. The direction of the net force acting on the coin is downward.
   D. The direction of the net force acting on the coin is upward.

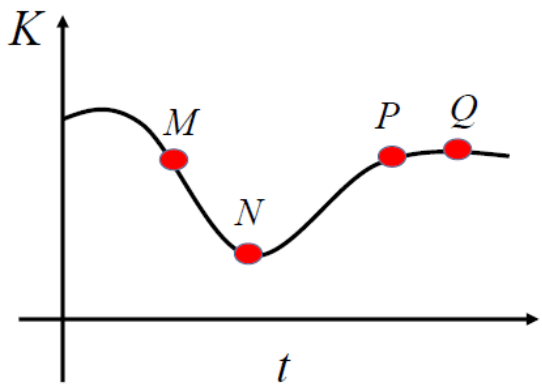
2. A dog sits at rest inside an elevator which is accelerating upward. The magnitude of the force that the elevator floor exerts on the dog

   A. is equal to the weight of the dog.
   B. is larger than the weight of the dog.
   C. is smaller than the weight of the dog.
   D. depends only on the acceleration of the elevator.

3. A box is sliding down an inclined plane with a constant speed. Which of the following statements about the frictional force acting on the box is correct?

   A. Its magnitude is smaller than the weight of the box.
   B. Its magnitude is equal to the weight of the box.
   C. Its magnitude is larger than the weight of the box.
   D. Its magnitude does not depend on the weight of the box.

4. The figure shows the kinetic energy *K* of an object (moving along a straight line) as a function of time *t*. Which of the following descriptions is correct?



   A. The acceleration of the object is decreasing from *M* to *N*.
   B. The acceleration at *M* is approximately equal to that at *P*.
   C. The acceleration at *Q* is larger than that at *N*.
   D. The net force acting on the object between *P* and *Q* is approximately zero.

多項選擇題 (45 分)

1. 一枚硬幣在液體中以均速垂直下落。以下哪項關於運動過程的描述是正確的?

   A. 硬幣的加速度保持不變。
   B. 硬幣的加速度增加。
   C. 作用在硬幣上的淨力方向向下。
   D. 作用在硬幣上的淨力方向向上。

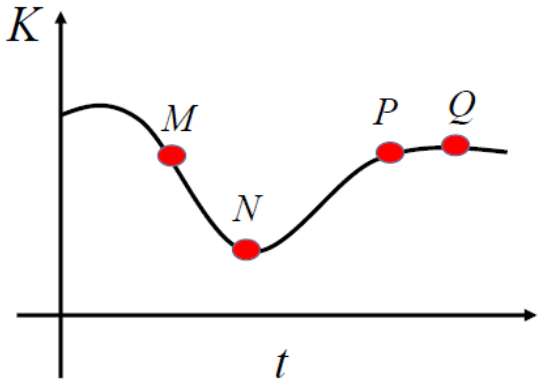
2. 一小狗靜坐在一架向上加速的電梯內。電梯地面給予小狗的力的量值

   A. 相等於小狗的重量。
   B. 大於小狗的重量。
   C. 少於小狗的重量。
   D. 只取決於電梯的加速度。

3. 一個盒子在一斜面上以均速滑落。以下哪項關於作用在盒子上的摩擦力是正確的?

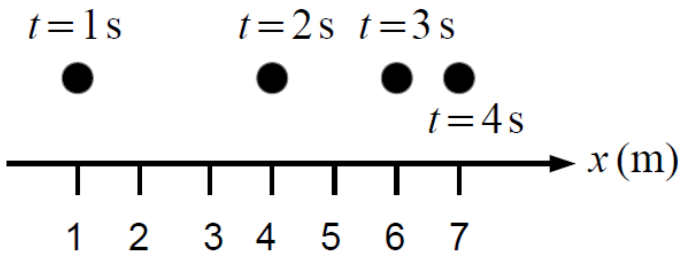
   A. 它的量值少於盒子的重量。
   B. 它的量值相等於盒子的重量。
   C. 它的量值大於盒子的重量。
   D. 它的量值跟盒子的重量沒有關係。

4. 下圖顯示一沿直線運動物件的動能 K 跟時間 t 的關係。以下哪項描述是正確的?



   A. 物件的加速度在 M 與 N 點之間減少。
   B. 物件在 M 和 P 點的加速度大致相同。
   C. Q 點的加速度大於 N 點的加速度。
   D. 作用在物件的淨力在 P 與 Q 點之間大約等於零。

5. The figure shows the positions x of a particle moving under constant acceleration at different times t. Which of the following statements is correct?



A. The average velocity of the particle between t = 1 s and 3 s is the same as that between t = 2 s and 4 s.
B. The net force acting on the particle is towards the negative x direction.
C. The net force acting on the particle is towards the positive x direction.
D. The kinetic energy of the particle is increasing between t = 1 s and 3 s, but decreasing between t = 2 s and 4 s.

6. When a beam of light wave passes from water to air,

A. its wavelength increases.
B. its speed remains unchanged.
C. its frequency increases.
D. its wavelength decreases.

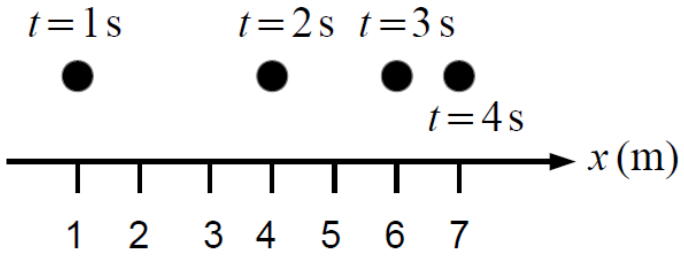
7. A particle of charge q and mass m is accelerating along a straight line in a uniform electric field. A second particle of charge $4q$ and mass $2m$ is accelerating in the same electric field. Which of the following statements about the acceleration of the second particle is correct?

A. It is half of that of the first particle.
B. It is two times that of the first particle.
C. It is four times that of the first particle.
D. It is the same as that of the first particle.

8. A stone of mass m is thrown vertically upward into the sky. The initial speed is v_0. What is the stone's acceleration when it reaches the highest point?

A. 0
B. g
C. mv_0
D. mg

5. 下圖顯示一沿直線以等加速度運動粒子在不同時間 t 的位置 x。以下哪項是正確的?



A. 粒子在 t = 1 秒和 3 秒之間的平均速度等於在 t = 2 秒和 4 秒之間的平均速度。
B. 作用在粒子的淨力向負 x 方向。
C. 作用在粒子的淨力向正 x 方向。
D. 粒子的動能在 t = 1 秒和 3 秒之間增加，但在 t = 2 秒和 4 秒之間減少。

6. 當一束光波從水進入空氣，

A. 它的波長增加。
B. 它的速度保持不變。
C. 它的頻率增加。
D. 它的波長減少。

7. 一顆電荷為 q 和質量為 m 的粒子在均勻的電場中直線加速。第二顆電荷為 $4q$ 和質量為 $2m$ 的粒子在同一電場中加速。以下哪項關於第二顆粒子加速度是正確的?

A. 它是第一顆粒子加速度的一半。
B. 它是第一顆粒子加速度的兩倍。
C. 它是第一顆粒子加速度的四倍。
D. 它跟第一顆粒子加速度相等。

8. 一塊質量為 m 的石頭被向上垂直拋。其起始速度為 v_0。當石頭到達最高點的時候，石頭的加速度是多少？

A. 0
B. g
C. mv_0
D. mg

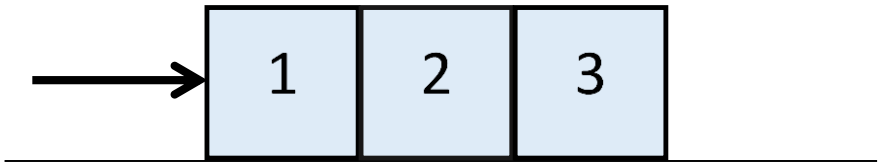
9. In an experiment, a block slides down a rough inclined plane with a decreasing speed. Which of the following statements about the experiment is correct?

   A. The mass of the block must be small, so that the gravitational force on it is negligible.
   B. The inclination angle must be larger than $45°$.
   C. The friction and the motion are in the opposite direction.
   D. The situation described in the question is impossible.

10. A man of height $1.8\ \mathrm{m}$ stands at a distance $3.6\ \mathrm{m}$ from a mirror. What is the height of the reflected image?

   A. $0.9\ \mathrm{m}$
   B. $1.8\ \mathrm{m}$
   C. $3.6\ \mathrm{m}$
   D. $7.2\ \mathrm{m}$

11. Three identical blocks are put on a smooth horizontal surface. An external force is applied to the first block, such that the three blocks move together towards the right.



   Which of the three blocks experiences the largest net force?
   A. Block 1
   B. Block 2
   C. Block 3
   D. The net force on each of the three blocks is identical.

12. In an experiment, a wire is connected to a battery in a complete circuit. Which of the following statements best describes the experiment?

   A. The atoms move along the wire in the direction of the current.
   B. The nuclei move along the wire in the direction of the current.
   C. There is no current in the circuit, because there is no resistance.
   D. The chemical energy stored in the battery is converted to electrical energy.

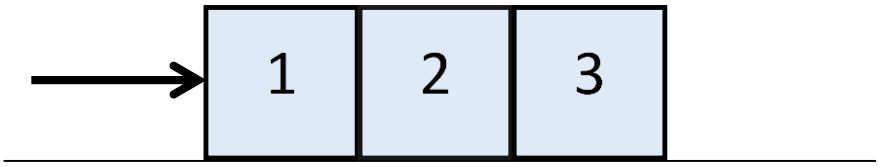
9. 在一個實驗裏，一方塊滑下一個粗糙的斜面，其速度一直下降。以下那一句關於這個實驗的句子是正確的？

A. 方塊的質量一定很小，以致其引力可以忽略。
B. 斜坡的傾斜度一定大於 45°。
C. 阻力的方向和運動方向相反。
D. 問題中描述的情況沒有可能發生。

10. 一高度為 1.8 米的男子站在距離一塊鏡子 3.6 米的地方。反射的影像高度是多少？

A. 0.9 米
B. 1.8 米
C. 3.6 米
D. 7.2 米

11. 三個相同的方塊被放在一個平滑的平面上。一外力施加於第一個方塊上，以致三個方塊一同向右邊移動。



三個方塊中，那一個承受最大的淨力？
A. 方塊 1
B. 方塊 2
C. 方塊 3
D. 在每一個方塊上的淨力均相同

12. 在一個實驗裏，一條電線在一個完整電路裏連接到一個電池。 以下那一句句子最能描述這個實驗？

A. 原子順着電流的方向沿着電線移動。
B. 原子核順着電流的方向沿着電線移動。
C. 由於沒有電阻，電路裏沒有電流。
D. 儲存在電池裏的化學能轉化為電能。

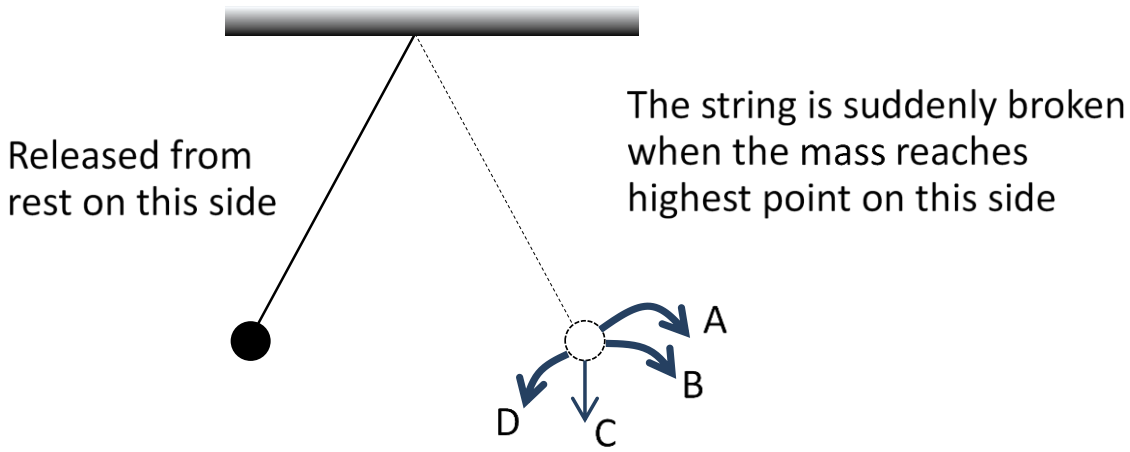
13. Assume that the distance between the Earth and the Sun is d, and the solar radiation power received by the Earth is E. If the distance between another Earth-sized planet and the Sun is $d/2$, what is the solar radiation power received by the planet?

A. $E/4$
B. $E/2$
C. $2E$
D. $4E$

14. The resistance of a copper wire is R. If the wire is melted, and recast to a thinner wire with twice the original length, what can we conclude about the resistance of the recast wire?

A. The resistance is equal to R.
B. The resistance is larger than R.
C. The resistance is smaller than R.
D. There is not enough information to make any conclusion about the resistance.

15. A student holds the mass of a simple pendulum, and releases it in the position shown in the figure. When the mass reaches the highest point on the other side, the string is suddenly broken.



Which of the following paths best represents the subsequent movement of the mass?

A. A
B. B
C. C
D. D

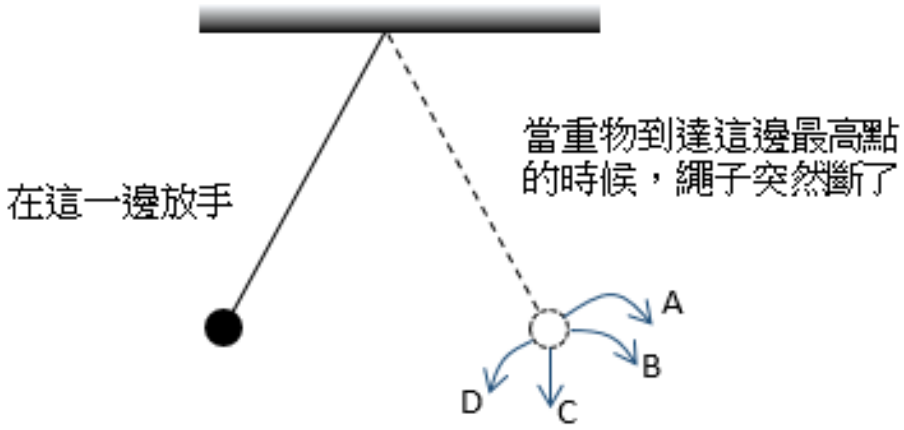
13. 假設地球和太陽的距離是 d，而地球接收到的太陽輻射功率是 E。如果另一個和地球大小相同的行星和太陽的距離是 $d/2$，行星接收到的太陽輻射功率是多少？

A. $E/4$
B. $E/2$
C. $2E$
D. $4E$

14. 一條銅線的電阻是 R。如果熔化了這條電線，並將它重鑄為一條兩倍原有長度的較幼電線，我們可以對重鑄的電線的電阻作什麼結論？

A. 其電阻等於 R
B. 其電阻大於 R
C. 其電阻小於 R
D. 沒有足夠的資料作任何關於其電阻的結論

15. 一學生持着一個簡單鐘擺的重物，在圖中顯示的位置放手。當重物到達另一邊最高點的時候，繩子突然斷了。



以下那一條路徑最能表達重物其後的運動？

A. A
B. B
C. C
D. D

16. The density and concentration of a saturated solution are 1.5 g/ml and 0.15 g/ml, respectively. At least how much solvent is needed to dissolve 10 g of the solute?

A. 80 g
B. 90 g
C. 100 g
D. 110 g

17. Consider following information of a molecule：
(I) The molecular formula is CON_2H_4.
(II) The C, O, and N atoms are connected in the following pattern: N~O~C~N, in which each "~" may be single, double, or triple bond.
(III) It obeys the octet rule.

How many H atom(s) is/are bonded to <u>each</u> of the N atoms?
A. One N atom does <u>not</u> have H atom bonded to it and the other N atom has one H atom bonded to it.
B. Each N atom has one H atom bonded to it.
C. One N atom has one H atom bonded to it and the other N atom has two H atoms bonded to it.
D. Each N atom has two H atoms bonded to it.

18. Which of the following are involved in solid ammonium hydrogen sulphide, $[NH_4^+][HS^-]$?
(I) Hydrogen bond
(II) Covalent bond
(III) Ionic bond

A. (I) and (II) only
B. (I) and (III) only
C. (II) and (III) only
D. All of them

16. 一飽和溶液的密度及濃度分別是 1.5 g/ml 和 0.15 g/ml。至少需用若干溶劑方可溶解 10 g 的溶質？

A. 80 g
B. 90 g
C. 100 g
D. 110 g

17. 考慮以下關於某分子的資料：
(I) 分子式是 CON_2H_4。
(II) C、O 及 N 原子依照以下方式連結：N~O~C~N，其中「~」會是單鍵、雙鍵或叁鍵。
(III) 它遵從八隅體規則。

<u>每一個</u> N 原子與多少個 H 原子鍵合？
A. 一個 N 原子<u>沒有</u>與 H 原子鍵合，另一個 N 原子則與一個 H 原子鍵合。
B. 每一個 N 原子各自與一個 H 原子鍵合。
C. 一個 N 原子與一個 H 原子鍵合，另一個 N 原子則與兩個 H 原子鍵合。
D. 每一個 N 原子各自與兩個 H 原子鍵合。

18. 下列何者涉及在硫化氫銨 $[NH_4^+][HS^-]$ 固體之內？
(I) 氫鍵
(II) 共價鍵
(III) 離子鍵

A. 只有 (I) 和 (II)
B. 只有 (I) 和 (III)
C. 只有 (II) 和 (III)
D. 全部

19. Q, R, X, and Y are metal elements. To arrange their reactivities, a student carried out experiments and found that:
    (I) Metal Q is converted to Q^{2+}(aq) when Q is put into R^{2+}(aq) solution.
    (II) Heating oxide RO(s) gives metal R. But there is no reaction when oxides XO(s) and YO(s) are heated separately.
    (III) There is no reaction when a mixture of oxide XO(s) and metal Y is heated.

    Which of the following is the correct ascending order of reactivities of these four metal elements?
    A. Q < R < X < Y
    B. Q < Y < X < R
    C. R < Q < X < Y
    D. R < Q < Y < X

20. Q, R, X, and Y are elements. Assume Q can form Q^{2+} and Q^{3+} ions, whereas R, X, and Y can only form R^{+}, X^{-} and Y^{2-} ions, respectively. What is/are the possible value(s) of *q* in the chemical formula, $Q_2RX_3Y_q$, of ionic compound(s)? Note: the ionic compound(s) may contain(s) both Q^{2+} and Q^{3+} ions.

    A. 1 only
    B. 1 and 2 only
    C. 2 only
    D. 1, 2, and 3 only

21. When heated above 300 °C, NH_4NO_3 solid decomposes according to the following reaction:

$$\mathbf{2\ NH_4NO_3 \rightarrow 2\ N_2 + 4\ H_2O + O_2}$$

    How much O_2 can be obtained from the above decomposition of 100 g of NH_4NO_3?
    A. 10 g
    B. 15 g
    C. 20 g
    D. 30 g

19. Q、R、X 及 Y 是金屬元素。為了把它們的活性排序，一名學生進行實驗並發現：

(I) 當把金屬 Q 放進 $R^{2+}(aq)$ 溶液時，Q 會轉化為 $Q^{2+}(aq)$。

(II) 把氧化物 RO(s) 加熱得到金屬 R，但當把氧化物 XO(s)及 YO(s)分別加熱時，卻沒有反應。

(III) 當把氧化物 XO(s) 與金屬 Y 的混合物加熱時，並沒有反應。

以下何者是這四個金屬的活性的遞增次序？

A. Q < R < X < Y

B. Q < Y < X < R

C. R < Q < X < Y

D. R < Q < Y < X

20. Q、R、X 及 Y 均是元素。 假設 Q 可生成 Q^{2+} 和 Q^{3+} 離子，而 R、X 及 Y 則只能分別生成 R^{+}、X^{-} 及 Y^{2-} 離子。 在化學式為 $Q_2RX_3Y_q$ 的(一個或多於一個)離子化合物，q 的可能數值是什麼？註：該離子化合物可能同時含有 Q^{2+}及 Q^{3+} 離子。

A. 只有 1

B. 只有 1 和 2

C. 只有 2

D. 只有 1、2 和 3

21. 當把 NH_4NO_3 固體於 300 °C 以上加熱，它根據以下反應式分解：

$$\mathbf{2\ NH_4NO_3 \rightarrow 2\ N_2 + 4\ H_2O + O_2}$$

根據以上反應式，100 g 的 NH_4NO_3 固體的分解可得到若干 O_2？

A. 10 g

B. 15 g

C. 20 g

D. 30 g

22. In the following balanced chemical equation,

$$aX + bY_2Z_5^{2-} \rightarrow cX^{3-} + dYZ^{-} + eZ^{2+}$$

a, *b*, *c*, *d*, and *e* are positive integers in simplest ratio [e.g., (*a*, *b*, *c*, *d*, *e*) = (1, 1, 2, 2, 3) are in simplest ratio, but (*a*, *b*, *c*, *d*, *e*) = (2, 2, 4, 4, 6) are not]. What is the value of *c*?

A. 1
B. 2
C. 3
D. 4

23. Solution X is obtained when ammonia (NH_3) gas is passed into water. Which of the following statement(s) concerning Solution X is/are true?

(I) When an acid solution is added to X, a gas is given out.
(II) Solid ionic compound $[NH_4^+][OH^-]$ can be obtained by evaporating water from X.

A. None of them
B. (I) only
C. (II) only
D. All of them

24. Neutralisation reactions were carried out between the following 3 solutions:

Solution X: HCl(aq) solution, concentration: 10 g/L
Solution Y: NaOH(aq) solution, concentration: unknown
Solution Z: HCl(aq) solution, concentration: unknown

Determine the concentration of solution Z based on the following results of neutralisation.

- 0.015 L of solution X requires 0.025 L of solution Y to neutralise.
- 0.035 L of solution Z requires 0.045 L of solution Y to neutralise.

A. 2.7 g/L
B. 7.4 g/L
C. 13.5 g/L
D. 37.5 g/L

22. 在以下平衡（已配平）的化學方程式中，

$$aX + bY_2Z_5^{2-} \rightarrow cX^{3-} + dYZ^{-} + eZ^{2+}$$

a、*b*、*c*、*d* 和 *e* 是成最簡單比的正整數 [舉例：(*a*, *b*, *c*, *d*, *e*) = (1, 1, 2, 2, 3) 是成最簡單比，但 (*a*, *b*, *c*, *d*, *e*) = (2, 2, 4, 4, 6) 則否]。 *c* 的值是多少？

A. 1
B. 2
C. 3
D. 4

23. 當把氨 (NH_3) 氣通進水中便得到溶液 X。下列有關溶液 X 的陳述，何者正確？

(I) 把酸溶液加入 X 時，有氣體釋出。
(II) 把 X 中的水蒸發後，可得到離子化合物 $[NH_4^+][OH^-]$ 的固體。

A. 以上皆非
B. 只有 (I)
C. 只有 (II)
D. 全部

24. 利用下列 3 溶液互相進行中和反應：

溶液 X : HCl(aq) 溶液， 濃度： 10 g/L
溶液 Y : NaOH(aq) 溶液， 濃度：未知
溶液 Z : HCl(aq) 溶液， 濃度：未知

根據以下中和反應的結果測定溶液 Z 的濃度。

- 0.015 L 的溶液 X 需用 0.025 L 的溶液 Y 中和。
- 0.035 L 的溶液 Z 需用 0.045 L 溶液 Y 中和。

A. 2.7 g/L
B. 7.4 g/L
C. 13.5 g/L
D. 37.5 g/L

25. Which of the following is/are appropriate method(s) to collect hydrogen (H_2) gas?
    (I) Upward delivery (downward displacement of air)
    (II) Downward delivery (upward displacement of air)
    (III) Over water (displacement of water)

    A. (I) only
    B. (II) only
    C. (I) and (III) only
    D. (II) and (III) only

26. Which of the following chemical species do(es) <u>not</u> obey the octet rule?
    (I) NO_2
    (II) N_2O
    (III) N_2O_5

    A. (I) only
    B. (II) only
    C. (III) only
    D. (II) and (III) only

27. Which of the following processes can produce fresh water from sea water?
    (I) Distillation
    (II) Filtration
    (III) Centrifugation

    A. (I) only
    B. (II) only
    C. (I) and (III) only
    D. (II) and (III) only

28. Which of the following gases can relight a glowing splint?

    A. Hydrogen
    B. Nitrogen
    C. Nitrous oxide (N_2O)
    D. Carbon dioxide

25. 下列何者是收集氫 (H_2) 氣的適當方法？

(I) 向上導氣法 (向下排空氣法)
(II) 向下導氣法 (向上排空氣法)
(III) 在水中集氣 (排水集氣法)

A. 只有 (I)
B. 只有 (II)
C. 只有 (I) 和 (III)
D. 只有 (II) 和 (III)

26. 下列哪物種並不遵從八隅體規則？

(I) NO_2
(II) N_2O
(III) N_2O_5

A. 只有 (I)
B. 只有 (II)
C. 只有 (III)
D. 只有 (II) 和 (III)

27. 以下哪過程可從海水得到淡水？

(I) 蒸餾
(II) 過濾
(III) 離心分離

A. 只有 (I)
B. 只有 (II)
C. 只有 (I) 和 (III)
D. 只有 (II) 和 (III)

28. 以下哪一氣體能令帶火星／餘燼的木條重燃？

A. 氫
B. 氮
C. 一氧化二氮 (N_2O)
D. 二氧化碳

29. It is known that the chemical reaction between 100 g of element X and 300 g of element Y results in compound Z with 100 g of Y left. Based on the above information, the chemical reaction between 300 g of element X and 100 g of element Y will result in compound Z with

A. 150 g of X left.
B. 200 g of X left.
C. 250 g of X left.
D. 300 g of X left.

30. Consider the following reaction:

$$\mathbf{Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)}$$

Which of the following can increase the reaction rate?
(I) Using HCl(aq) of lower temperature
(II) Using HCl(aq) with higher concentration
(III) Using finer solid for Zn(s)

A. (I) and (II) only
B. (I) and (III) only
C. (II) and (III) only
D. All of them

29. 已知：100 g 的元素 X 與 300 g 的元素 Y 起化學反應得到化合物 Z，並餘下 100 g 的 Y。根據以上資料，300 g 的元素 X 與 100 g 的元素 Y 起化學反應得到化合物 Z，並

A. 餘下 150 g 的 X 。
B. 餘下 200 g 的 X 。
C. 餘下 250 g 的 X 。
D. 餘下 300 g 的 X 。

30. 考慮以下反應：

$$\mathbf{Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)}$$

下列何者可令反應速率增加？
(I) 使用溫度較低的 HCl(aq)
(II) 使用濃度較高的 HCl(aq)
(III) 使用較細碎的固體 Zn(s)

A. 只有 (I) 和 (II)
B. 只有 (I) 和 (III)
C. 只有 (II) 和 (III)
D. 全部

Answer **Q31** and **Q32** based on the following information

Osmosis is the movement of free water molecules, from a region of higher concentration to a region of lower concentration, through a partially permeable membrane. Partially permeable membranes, which are also called selectively permeable membranes or semi-permeable membranes, allow some molecules to pass through them, but not others.

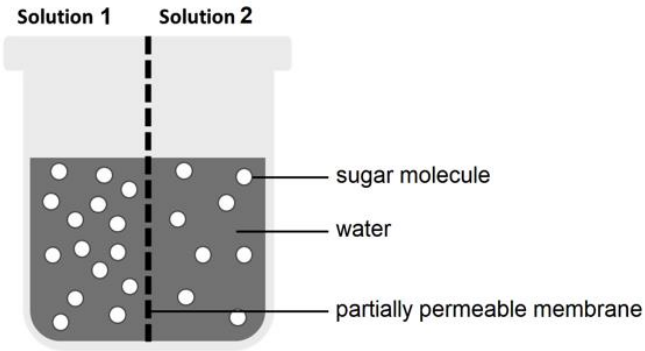


Figure above shows the initial setting of an experiment. Both Solution 1 and Solution 2 contained a water-soluable sugar which molecules were too big to pass through the partially permeable membrane.

31. Which of the following are **possible** changes after 30 minutes?
    (I) Water level of Solution 1 would increase.
    (II) Sugar concentration of Solution 2 would increase.
    (III) Number of sugar molecules in Solution 1 would remain unchanged.

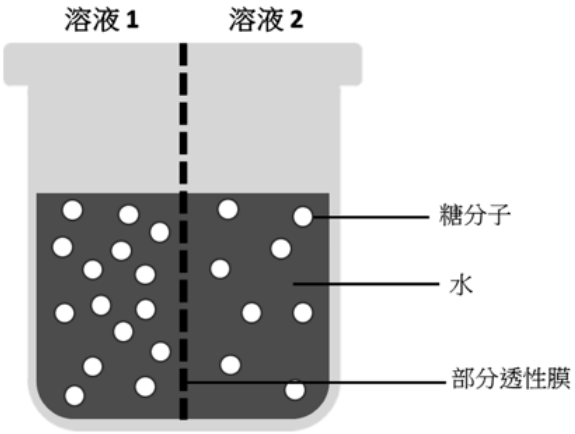
    A. (I) and (II) only.
    B. (II) and (III) only.
    C. (I) and (III) only.
    D. (I), (II) and (III).

32. Which of following statements are **true** from 0 to 30th minute?
    (I) Some water molecules of Solution 1 moved to Solution 2.
    (II) Some water molecules of Solution 2 moved to Solution 1.
    (III) There are intermolecular forces between sugar molecules and water molecules.
    (IV) There are no intermolecular forces among water molecules.

    A. (I) and (III) only.
    B. (II) and (III) only.
    C. (I), (II) and (III) only.
    D. (I), (II) and (IV) only.

根據以下資料，回答 **Q31** 和 **Q32**。

滲透作用是自由的水分子由濃度較高的區域，穿越部分透性膜移動至濃度較低的區域。部分透性膜亦稱為選透性膜或半透性膜，可以讓某些分子穿越，但不讓其他分子穿越。



上圖顯示一項實驗開始時的裝置，溶液 1 和溶液 2 同樣含有一種水溶性糖，糖分子因太大而不能從部分透性膜穿過。

31. 下列哪項是 30 分鐘後<u>可能</u>出現的變化?
   (I) 溶液 1 的液面會上升。
   (II) 溶液 2 的糖濃度會增加。
   (III) 溶液 1 的糖分子數目會保持不變。

   A. 只有 (I) 和 (II)。
   B. 只有 (II) 和 (III)。
   C. 只有 (I) 和 (III)。
   D. (I), (II) 和 (III)。

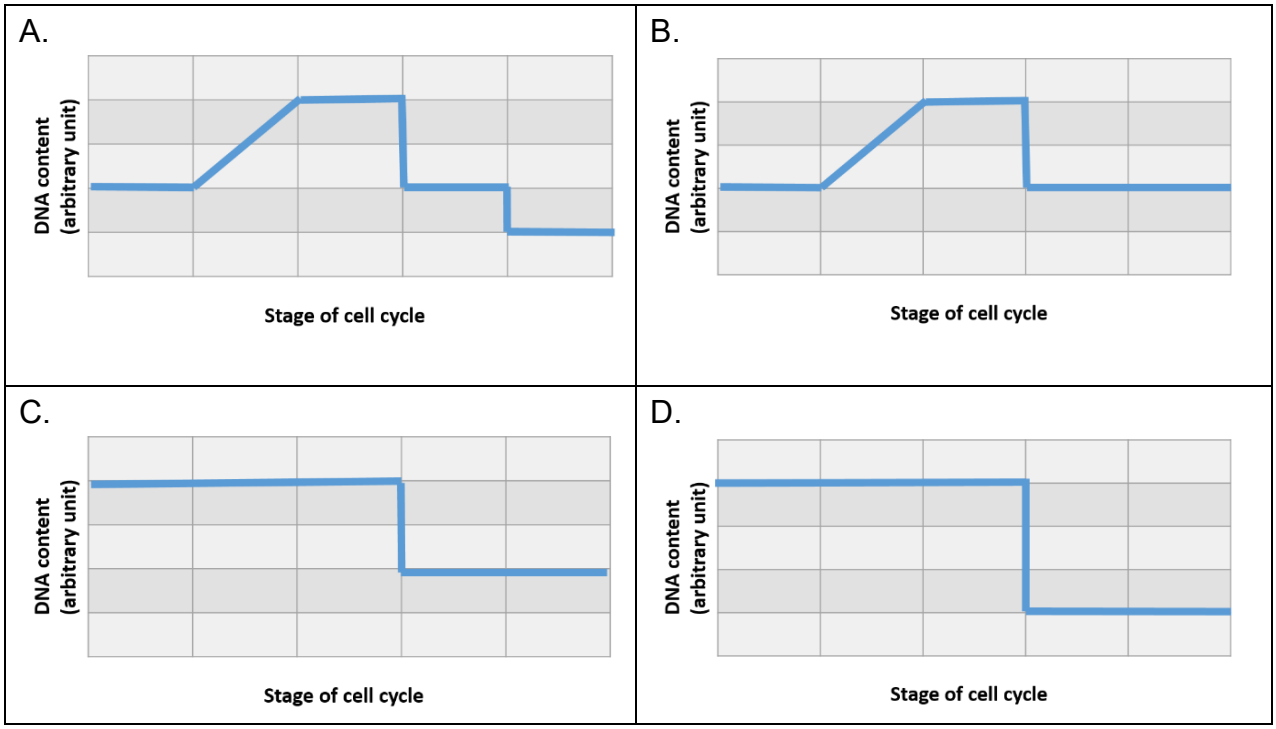
32. 從 0 到第 30 分鐘，下列哪項陳述是<u>真確</u>的?
   (I) 有些水分子由溶液 1 移動至溶液 2。
   (II) 有些水分子由溶液 2 移動至溶液 1。
   (III) 糖分子和水分子之間有分子間作用力。
   (IV) 水分子之間沒有分子間作用力。.

   A. 只有 (I) 和 (III)。
   B. 只有 (II) 和 (III)。
   C. 只有 (I)，(II) 和 (III)。
   D. 只有 (I)，(II) 和 (IV)。

Answer **Q33** and **Q34** based on the following information.

Mitosis is a type of cell division which results in the formation of two daughter cells from a mother cell. Daughter cells and the mother cell are genetically identical.

33. Which of the following pictures shows the **correct** change of DNA content from the newly formed mother cell to the newly formed daughter cell?
(y-axis: DNA content (arbitrary unity), x-axis: Stage of cell cycle)



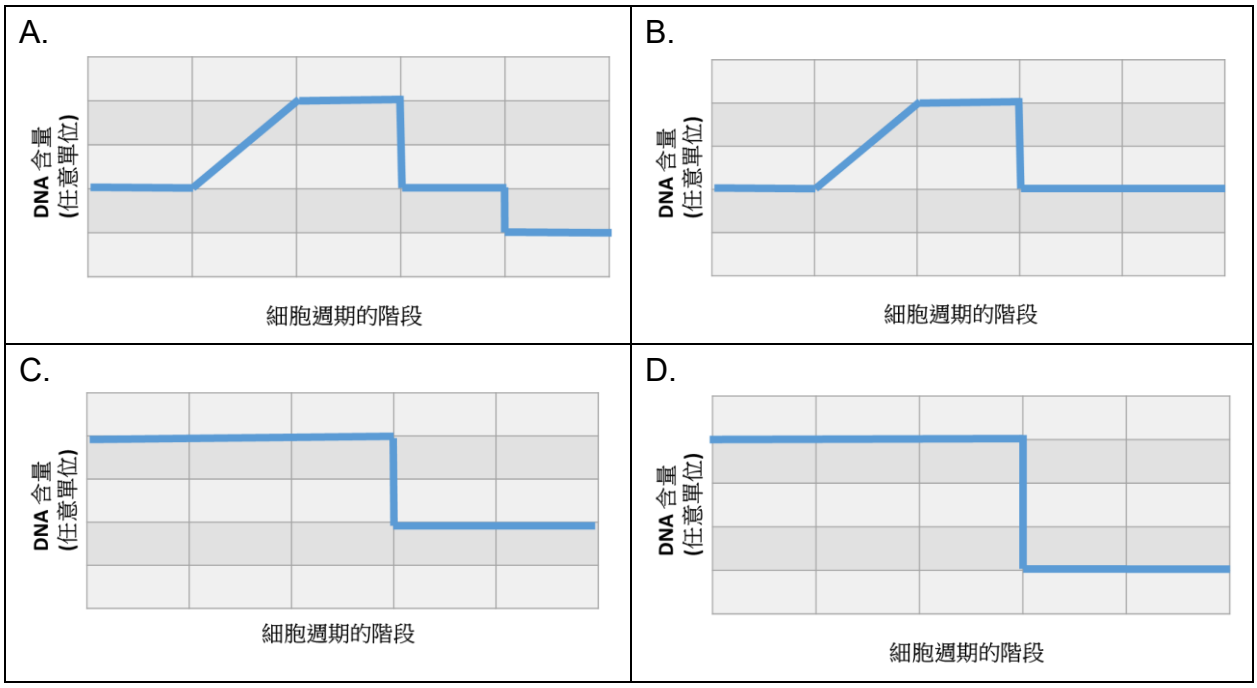
34. Mitosis is involved directly to produce
(I) sperm cells
(II) plant ovary
(III) onion's bulb

A. (II) only.
B. (III) only.
C. (II) and (III) only.
D. (I), (II) and (III).

根據以下資料，回答 **Q33** 和 **Q34**。

有絲分裂是一種細胞分裂，由一個母細胞形成兩個子細胞，子細胞和母胞在遺傳上是相同的。

33. 下列哪圖顯示由新形成的母細胞至新形成的子細胞期間，細胞的 DNA 含量的<u>正確</u>變化? (y 軸: DNA 含量 (任意單位)，x 軸: 細胞週期的階段)



34. 有絲分裂直接地涉及生成

(I) 精子細胞
(II) 植物的子房
(III) 洋蔥的鱗莖

A. 只有 (II)。
B. 只有 (III)。
C. 只有 (II) 和 (III)。
D. (I)，(II) 和 (III)。

Answer **Q35** and **Q36** based on the following information.

Below shows the central dogma of molecular biology.

In nucleus, DNA is stored in form of chromosomes which cannot pass through the nuclear pores (the holes of nuclear membrane). mRNA is produced through transcription with DNA used as a template. In cytoplasm, mRNA undergoes translation in which amino acids are assembled into protein. mRNA is reusable in this process.

35. Which of the following statements is/are **correct**?
    (I) mRNA can be found in both nucleus and cytoplasm.
    (II) In general, the rate of mRNA synthesis is positively co-related to the transcriptional rate of its corresponding gene but negatively co-related to its translational rate.
    (III) In general, the rate of protein synthesis is positively co-related to the transcriptional and translational rates of its corresponding gene.

    A. (I) and (II) only.
    B. (II) and (III) only.
    C. (I) and (III) only.
    D. (I), (II) and (III).

36. In a normally functioning cell, the level of mRNA of a gene will be downregulated by
    (I) increasing the rate of degradation of the corresponding gene.
    (II) reducing the rate of transcription of the corresponding gene.
    (III) increasing the rate of its translation.
    (IV) increasing the rate of its degradation.

    A. (I) and (II) only.
    B. (II) and (IV) only.
    C. (I), (II) and (IV) only.
    D. (I), (II), (III) and (IV).

根據以下資料，回答 **Q35** 和 **Q36**。

下圖顯示分子生物學的中心法則。

細胞核內的 DNA 以染色體的形式儲藏，染色體不能穿越核孔(核膜上的孔洞)。mRNA 是以 DNA 作為模板經轉錄而產生；在細胞質中，mRNA 經轉譯而令氨基酸合成為蛋白質，mRNA 可以在這個過程中重用。

35. 下列哪項陳述是<u>正確</u>的?

(I) mRNA 可同時見於細胞核和細胞質。
(II) mRNA 的合成速率與其轉錄對應基因的速率，通常是正相關的，但與它的轉譯速率則是負相關的。
(III) 蛋白質的合成速率與其對應基因的轉錄速率和轉譯速率，通常是正相關的。

A. 只有 (I) 和 (II)。
B. 只有 (II) 和 (III)。
C. 只有 (I) 和 (III)。
D. (I)，(II) 和 (III)。

36. 在一個正常運作的細胞中，某個基因的 mRNA 水平可以通過以下途徑(向)下調(整)：

(I) 增加對應基因的降解速率。
(II) 降低轉錄對應基因的速率。
(III) 增加它的轉譯速率。
(IV) 增加它的降解速率。

A. 只有 (I) 和 (II)。
B. 只有 (II) 和 (IV)。
C. 只有 (I)，(II) 和 (IV)。
D. (I)，(II)，(III) 和 (IV)。

37. Organism E contains ribosomes but not nucleus. Organism E can be a(n)

A. virus.
B. bacterium.
C. amoeba.
D. More than one of the above answer is correct.

38. Who is known as ‘Father of Microbiology’ who disproved the theory of spontaneous generation?

A. Louis Pasteur.
B. Charles Darwin.
C. James Watson.
D. Melvin Calvin.

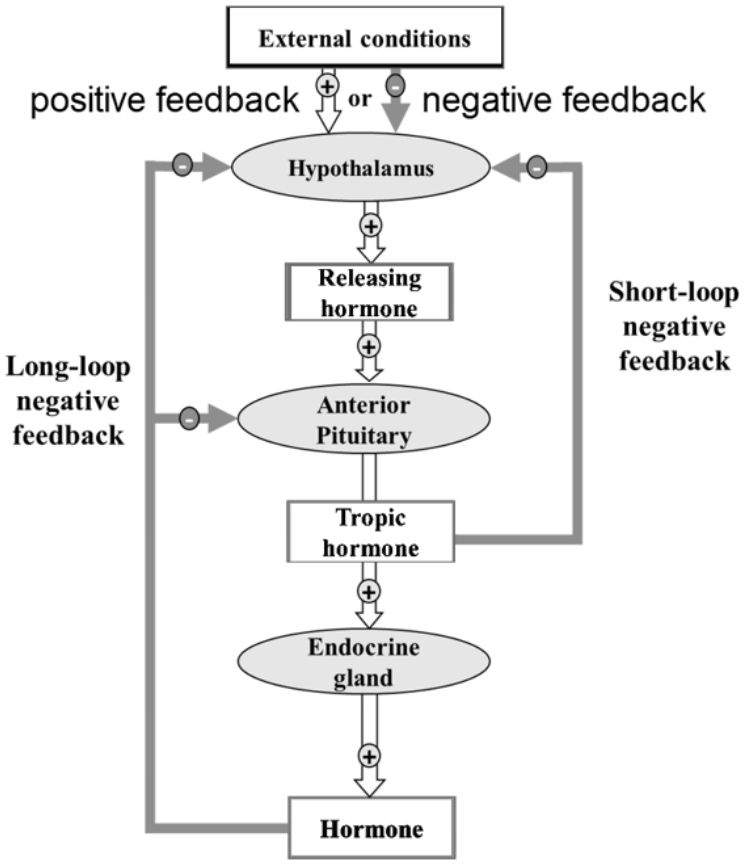
37. 生物 E 含有核糖體但沒有細胞核。生物 E 可以是

A. 病毒。
B. 細菌。
C. 變形蟲。
D. 以上答案中多於一個是正確的。

38. 誰否定了自然發生說的理論而被稱為「微生物學之父」?

A. 路易斯 · 巴斯德。
B. 查理士 · 達爾文。
C. 詹姆士 · 沃森。
D. 梅爾文 · 卡爾文。

Feedback reactions are commonly seen in biological systems. Often biological processes are linked to form feedback loops which can be classified as either positive or negative based on the types of feedback reactions involved. In a positive feedback loop, the output of the system amplifies the system reactions, while the output of a negative feedback loop inhibits the system. Answer **Q39** and **Q40** based on the following figure which shows the control of hormone synthesis in the human endocrine system.



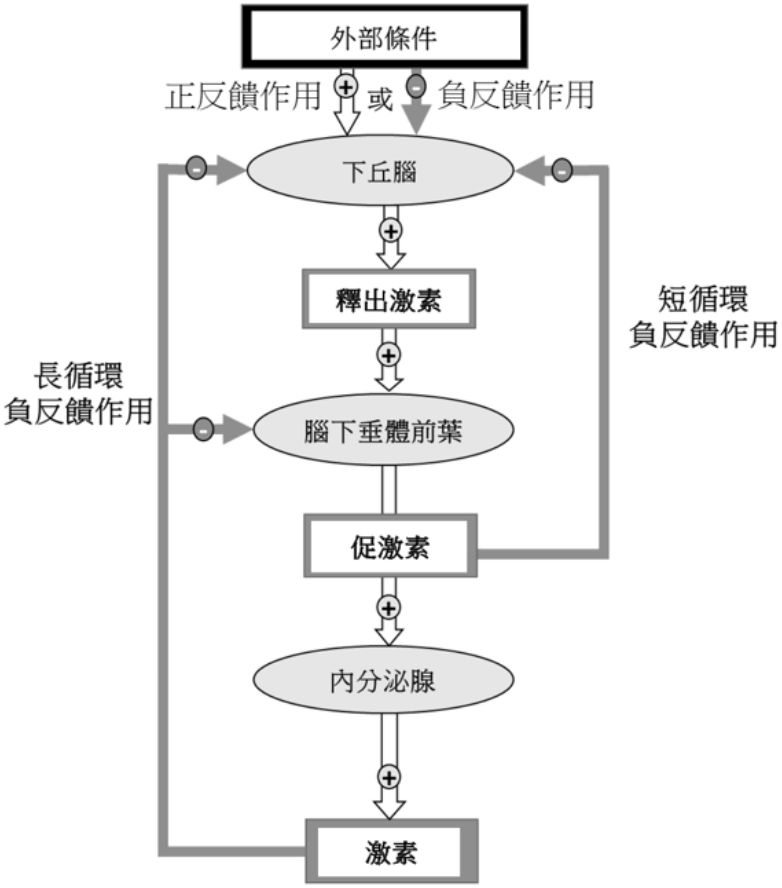
39. Which is the chief site of hormonal synthesis control?

A. Hypothalamus.
B. Anterior pituitary.
C. Posterior pituitary.
D. Individual endocrine glands which produce a particular hormone.

40. Which of the following statements on the feedback loop shown in the figure is **FALSE**?

A. Although both postitive and negative reactions are involved, the overall synthesis of hormones is basically a negative feedback loop.
B. Only biochemical signals are involved in the control of hormone synthesis.
C. Multiple steps and sites of regulation in the feedback loop allows fine tuning of hormonal synthesis.
D. None of the above statements is false.

回饋反應常見於生物系統中。生命過程經常連結起來形成反饋循環，這些循環可根據所涉及的反饋反應的類型而分為正反饋循環或負反饋循環。在正反饋循環，系統的輸出會擴增系統的反應；而在負反饋循環，系統的輸出則會抑制系統的反應。根據下圖所示人類內分泌系統控制激素合成的過程，回答 **Q39** 和 **Q40**。



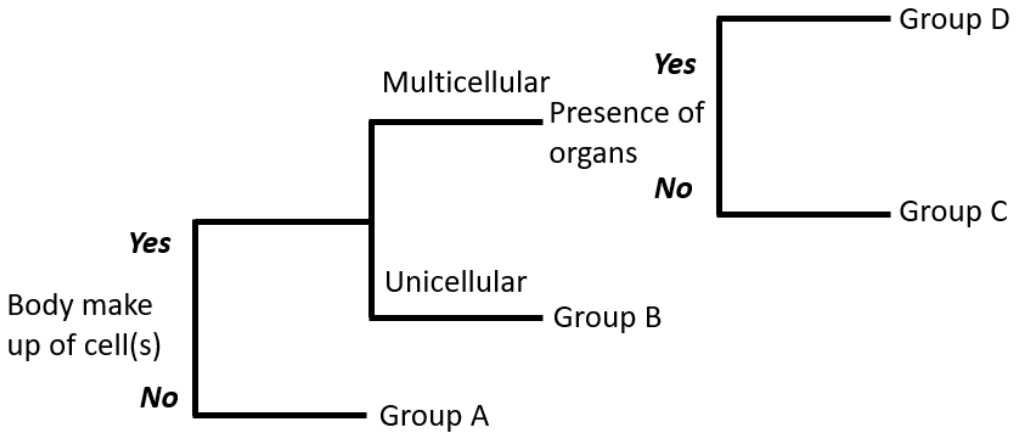
39. 哪個是控制激素合成的主要位置?

A. 下丘腦。
B. 腦下垂體前葉。
C. 腦下垂體後葉。
D. 每個內分泌腺各自產生特定的激素。

40. 下列哪項有關圖中顯示的反饋循環的陳述是<u>假</u>的?

A. 雖然正反應和負反應均有涉及，整體而言，激素的合成基本上是一個負反饋循環。
B. 控制激素的合成只涉及生物化學訊號。
C. 在反饋循環中有多個調控步驟及調控位置令激素的合成得以微調。
D. 以上的陳述無一是假的。

Answer **Q41** to **Q43** with reference to the following figure, which shows the grouping of some organisms by using a dichotomous key.



41. Which of the following statements is likely to be **FALSE**?

A. Organisms in Group A are most distantly related in phylogeny to members from other groups.
B. Organisms in Group B most likely lack a nucleus.
C. Organisms in Group C and Group D have cell types which are differentiated in functions.
D. None of the above statements is false.

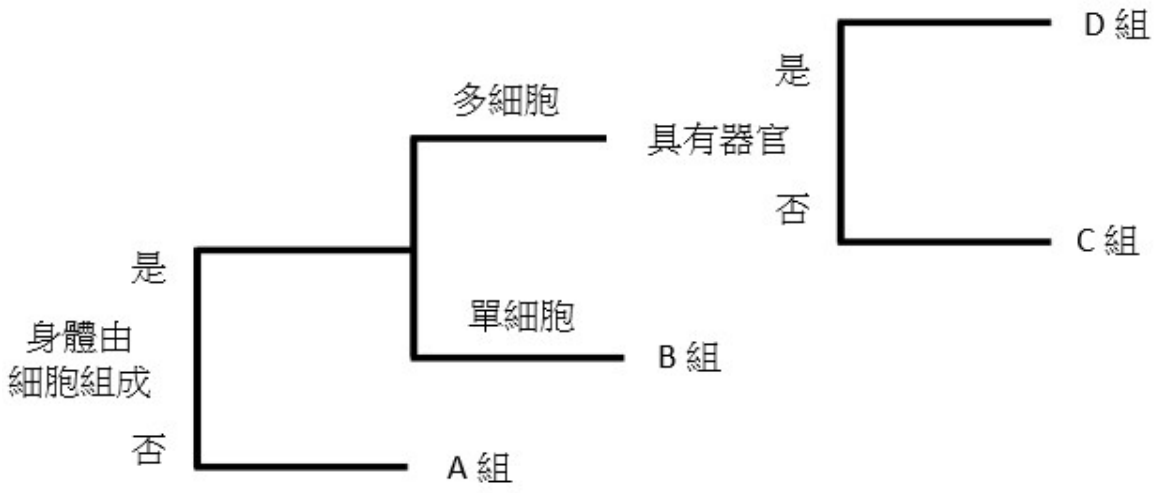
42. Examples of organisms from Group B and Group C are respectively:

A. bacteria and sponges.
B. bacteria and fungi.
C. viruses and bacteria.
D. None of the above combinations is correct.

43. Which of the following processes can only be found in some members from Group B but not in other groups?

A. Anaerobic respiration.
B. Nitrogen fixation.
C. Photosynthesis.
D. Endocytosis.

下圖顯示以二分索引把一些生物分類。根據下圖，回答 **Q41** 至 **Q43**。



41. 下列哪項陳述是很可能是<u>假</u>的?

A. A 組的生物在親緣上與其他組別的成員距離最遠。
B. B 組的生物最可能是缺少細胞核的。
C. C 組和 D 組的生物具有已分化為不同功能的細胞類型。
D. 以上的陳述無一是假的。

42. B 組和 C 組生物的例子分別是

A. 細菌和海綿。
B. 細菌和真菌。
C. 病毒和細菌。
D. 以上的組合無一是正確的。

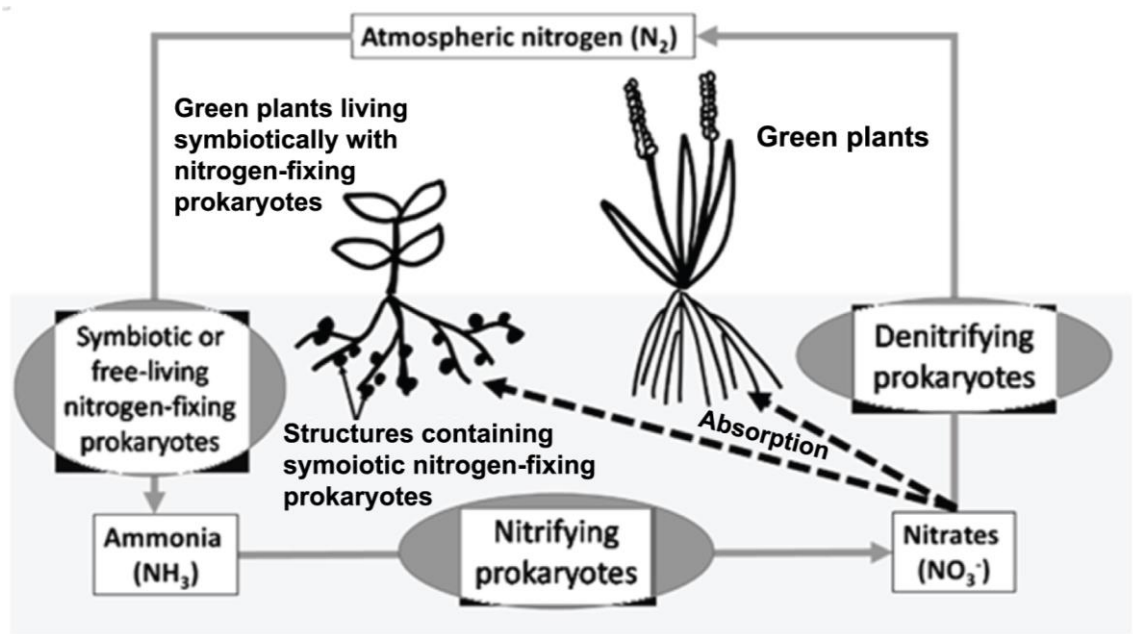
43. 以下哪過程只能見於 B 組的一些成員，而不見於其他組別?

A. 缺氧呼吸。
B. 固氮作用。
C. 光合作用。
D. 胞吞作用。

44. Human insulin can be synthesised by incorporating the human insulin gene into the DNA of a bacterium such as *E. coli*. Which of the following statements regarding this phenomenon is most likely to be **TRUE**?

A. Humans and *E. coli* are genetically close to each other.
B. A gene which codes for a protein similar to human insuilin may exist in the *E. coli* genome.
C. Both transcription and translation work under the same mechanisms in both species.
D. None of the above statements is true.

45. The figure below shows a simplified pathway in the nitrogen cycle. Nitrogen is essential for the growth of living organisms. There is a huge amount of nitrogen in the atmosphere but most organisms cannot make use of this resource due to their inability to break the strong triple bond between the nitrogen atoms in the nitrogen gas molecule. In nature, the conversion of nitrogen gas to ammonia (nitrogen fixation) by free living or symbiotic nitrogen-fixing prokaryotes plays an important role in the supply of nitrogen to other organisms. Which of the followings is the most practicable and effective way in enhancing the nitrogen contents of soil in agriculture without using fertilizers?



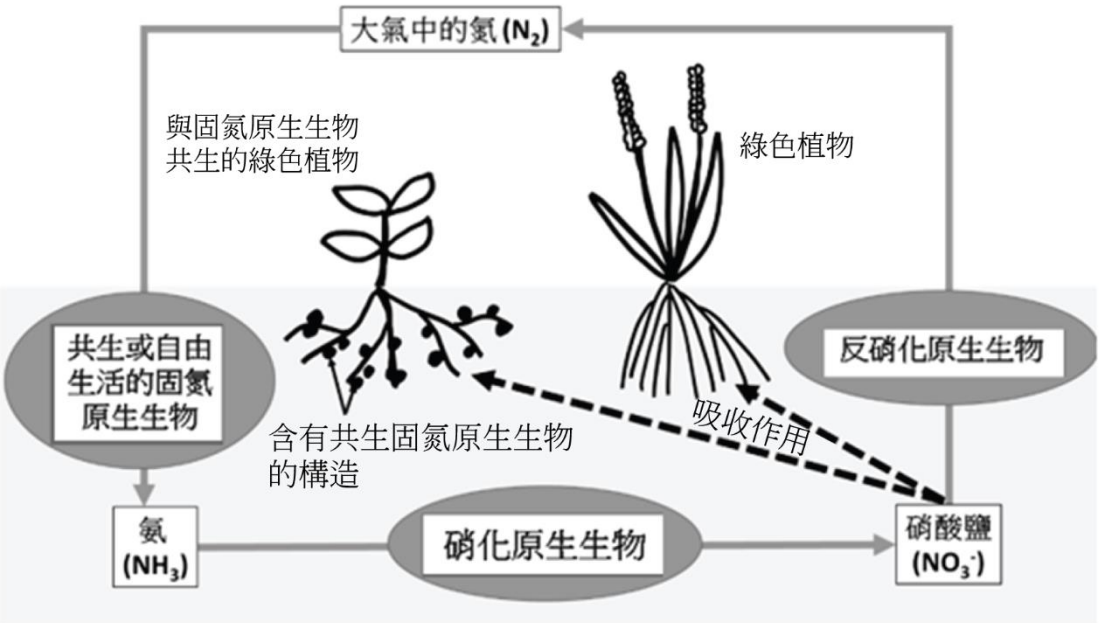
A. Incorporate free-living nitrogen fixing prokaryotes into crops.
B. Alternate growing of host plants of nitrogen fixing prokaryotes and other crops.
C. Promote the conditions which enhance the growth of nitrifying prokaryotes.
D. Promote the conditions which inhibit the growth of denitrifying prokaryotes.

End of Paper

44. 將人類胰島素基因加入細菌(例如大腸桿菌)的 DNA，可以合成人類胰島素。以下哪項有關這個現象的陳述最可能是<u>真確</u>的?

A. 人類和大腸桿菌彼此在遺傳上是相近的。
B. 大腸桿菌基因組中具有一個基因，其編碼類似人類胰島素的蛋白質。
C. 兩個物種均以相同的機制進行轉錄和轉譯。
D. 以上的組合無－是真確的。

45. 下圖顯示氮循環的簡略途徑。氮是生物生長所必需的，大氣中有大量的氮，但大部分生物不能分解氮氣分子的氮原子之間強大的三鍵，因而未能利用大氣中的氮。自然界中，自由生活或共生的固氮原生生物將氮氣轉化為氨(固氮作用)，在將氮供應給其他生物的過程中扮演重要的角色。在不使用肥料而又要增加土壤中的氮含量時，以下哪項是最可行和最有效的方法?



A. 將自由生活的固氮原生生物加入至農作物中。
B. 以輪替方式，種植固氮原生生物的寄主植物和其他農作物。
C. 提供增進硝化原生生物生長的條件。
D. 提供抑制去硝化原生生物生長的條件。

全卷完

香 港 資 優 教 育 學 苑
The Hong Kong Academy for Gifted Education

International Junior Science Olympiad 2022 – Hong Kong Screening

Answer

1. A	11. D	21. C	31. D	41. B
2. B	12. D	22. B	32. C	42. A
3. A	13. D	23. A	33. B	43. B
4. D	14. B	24. C	34. C	44. C
5. B	15. C	25. C	35. C	45. B
6. A	16. B	26. A	36. B	
7. B	17. C	27. A	37. B	
8. B	18. C	28. C	38. A	
9. C	19. D	29. C	39. A	
10. B	20. B	30. C	40. B	