



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

## International Junior Science Olympiad 2021 - 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  
Correct answer: +1.00 points  
Wrong answer: -0.33 points  
No answer: 0.00 point
4. Questions are in bilingual version.
5. Put your answers on the MC Answer Sheet.
6. Choose the BEST answer
7. Only calculators approved by The Hong Kong Examinations and Assessment Authority with “HKEAAAPPROVED” logo may be used for the contest. Measuring instruments like rulers, compasses, etc. can also be used. No stationeries will be provided.

## 2021 國際初中科學奧林匹克—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  
答對: +1.00 分  
答錯: -0.33 分  
沒有作答: 0.00 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. 請選擇最適當的答案。
7. 比賽時，學生可使用香港考試及評核局認可型號，印有“HKEAA APPROVED”的計算器。直尺、圓規及其它量度工具亦可輔助之用。大會不提供任何文具。

PERIODIC TABLE 周期表

GROUP 族

atomic number 原子序

14		relative atomic mass 相對原子質量										0	
H 1.0												He 4.0	
												VII	
												VI	
												V	
												IV	
												III	
												5	
												6	
												7	
												8	
												9	
												10	
												11	
												12	
												13	
												14	
												15	
												16	
												17	
												18	
												19	
												20	
												21	
												22	
												23	
												24	
												25	
												26	
												27	
												28	
												29	
												30	
												31	
												32	
												33	
												34	
												35	
												36	
												37	
												38	
												39	
												40	
												41	
												42	
												43	
												44	
												45	
												46	
												47	
												48	
												49	
												50	
												51	
												52	
												53	
												54	
												55	
												56	
												57	
												58	
												59	
												60	
												61	
												62	
												63	
												64	
												65	
												66	
												67	
												68	
												69	
												70	
												71	
												72	
												73	
												74	
												75	
												76	
												77	
												78	
												79	
												80	
												81	
												82	
												83	
												84	
												85	
												86	
												87	
												88	
												89	
												90	
												91	
												92	
												93	
												94	
												95	
												96	
												97	
												98	
												99	
												100	
												101	
												102	
												103	
												104	
												105	
												106	
												107	
												108	
												109	
												110	
												111	
												112	
												113	
												114	
												115	
												116	
												117	
												118	
												119	
												120	
												121	
												122	
												123	
												124	
												125	
												126	
												127	
												128	
												129	
												130	
												131	
												132	
												133	
												134	
												135	
												136	
												137	
												138	
												139	
												140	
												141	
												142	
												143	
												144	
												145	
												146	
												147	
												148	
												149	
												150	
												151	
												152	
												153	
												154	
												155	
												156	
												157	
												158	
												159	
												160	
												161	
												162	
												163	
												164	
												165	
												166	
												167	
												168	
												169	
												170	
												171	
												172	
												173	
												174	
												175	
												176	
												177	
												178	
												179	
												180	
												181	
												182	
												183	
												184	
												185	
												186	
												187	
												188	
												189	
												190	
												191	
												192	
												193	
												194	
												195	
												196	
												197	
												198	
												199	
												200	
												201	
												202	
												203	
												204	
												205	
												206	
												207	
												208	
												209	
												210	
												211	
												212	
												213	
												214	
												215	
												216	
												217	
												218	
												219	
												220	
												221	
												222	
												223	
												224	
												225	
												226	
												227	
												228	
												229	
												230	
												231	
												232	
												233	
												234	
												235	
												236	
												237	
												238	
												239	
												240	
												241	
												242	
												243	
												244	
												245	
												246	
												247	
												248	
												249	
												250	
												251	
												252	
												253	
												254	
												255	
												256	
												257	
												258	
												259	
												260	
												261	
												262	
												263	
												264	
												265	
												266	
												267	
												268	
												269	
												270	
												271	
												272	
												273	
												274	
												275	
												276	
												277	
												278	
												279	
												280	
												281	
												282	
												283	
												284	
												285	
												286	
												287	
												288	
												289	
												290	
												291	
												292	
												293	
												294	
												295	
												296	
												297	
												298	
												299	
												300	
												301	
												302	
												303	
												304	
												305	
												306	
												307	
												308	
												309	
												310	
												311	
												312	
												313	
												314	
												315	
												316	
												317	
												318	
												319	
												320	
												321	
												322	
												323	
												324	
												325	
												326	
												327	
												328	
												329	
												330	
												331	
												332	
												333	
												334	
												335	
												336	
												337	
												338	
												339	
												340	
												341	
												342	
												343	
												344	
												345	
												346	
												347	
												348	
												349	
												350	
												351	
												352	
												353	
												354	
												355	
												356	
												357	
												358	
												359	
												360	
												361	
												362	
												363	
												364	
												365	
												366	
												367	
												368	
												369	
												370	
												371	
												372	
												373	
												374	
												375	
												376	
												377	
												378	
												379	
												380	
												381	
												382	
												383	
												384	
												385	
												386	
												387	
												388	
												389	
												390	
												391	
												392	
												393	
												394	
												395	
												396	
												397	
												398	
												399	
												400	
												401	
												402	
												403	
												404	
												405	
												406	
												407	
												408	
												409	
												410	
												411	
												412	
												4	

## 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

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

$$\text{Kinetic energy 動能} = \frac{1}{2}mv^2$$

$$\text{Potential energy 潛能} = mgh$$

$$\text{Force 力} : F = ma$$

Electrical resistance 電阻

$$R = V/I$$

$$R = R_1 + R_2 \quad \text{in series 串聯}$$

$$1/R = 1/R_1 + 1/R_2 \quad \text{in parallel 並聯}$$

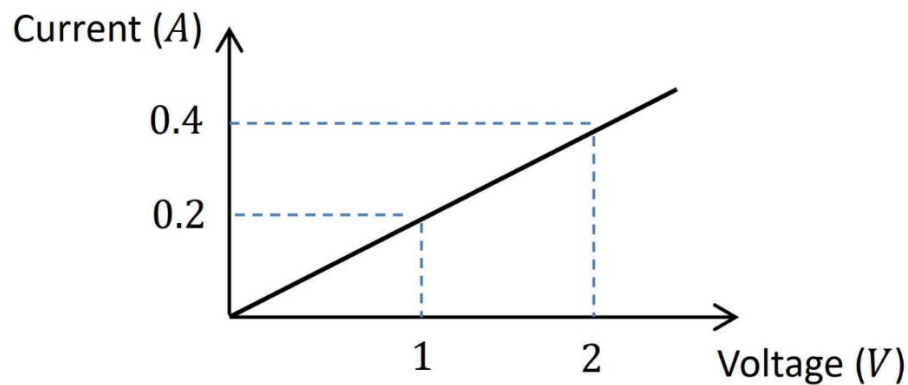
$$\text{Electrical power 電功率} : P = IV = V^2/R = I^2R$$

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

$$\text{Law of universal gravitation 萬有引力定理} \quad F = Gm_1m_2/r^2$$

## Multiple Choice Questions (45 marks)

1. The following plot shows the change of the current  $I$  for different values of the voltage  $V$  across a resistor. What is the resistance of the resistor?

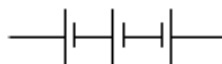


- A.  $0.4 \, \Omega$   
 B.  $1 \, \Omega$   
 C.  $2 \, \Omega$   
 D.  $5 \, \Omega$
2. Three ideal batteries (each with an e.m.f. of  $1.5 \, \text{V}$ ) are connected in the following ways. What is the voltage across the two ends in each case?

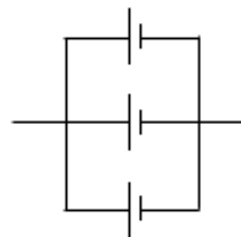
(I)



(II)



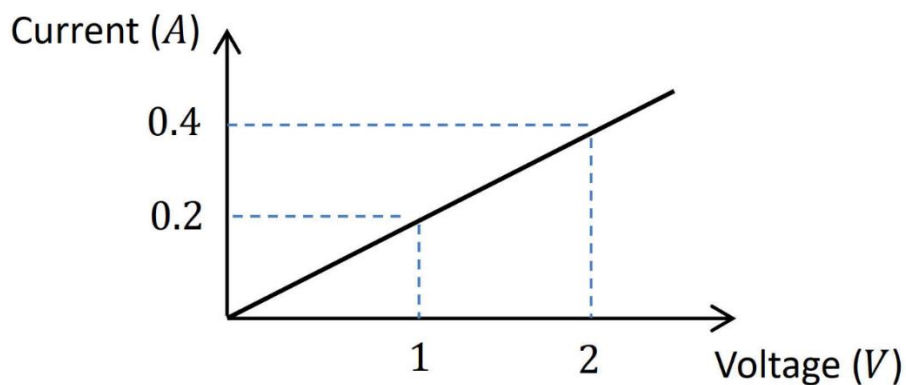
(III)



- |    | <u>I</u>          | <u>II</u>         | <u>III</u>        |
|----|-------------------|-------------------|-------------------|
| A. | $1.5 \, \text{V}$ | $1.5 \, \text{V}$ | $4.5 \, \text{V}$ |
| B. | $4.5 \, \text{V}$ | $1.5 \, \text{V}$ | $1.5 \, \text{V}$ |
| C. | $1.5 \, \text{V}$ | $4.5 \, \text{V}$ | $4.5 \, \text{V}$ |
| D. | $4.5 \, \text{V}$ | $4.5 \, \text{V}$ | $1.5 \, \text{V}$ |

## 多項選擇題 (45 分)

1. 下圖顯示當不同的電壓  $V$  施加於一個電阻時，電流  $I$  如何改變。電阻值是多少？

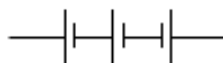


- A.  $0.4 \Omega$   
 B.  $1 \Omega$   
 C.  $2 \Omega$   
 D.  $5 \Omega$
2. 三個理想電池（每個電池的電動勢為  $1.5 \text{ V}$ ）根據以下的方法連起來。在每種方法下，兩端之間的電勢差是多少？

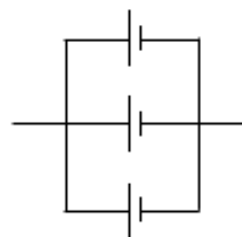
(I)



(II)



(III)



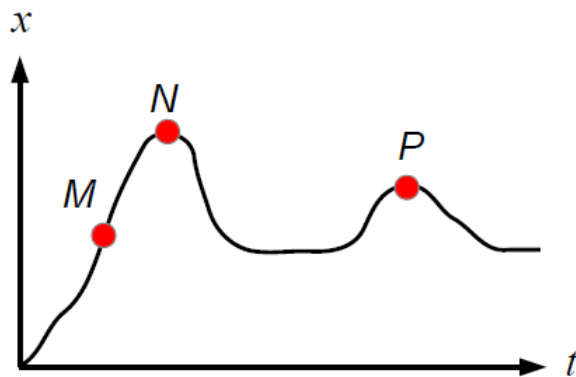
- |    | <u>I</u>        | <u>II</u>       | <u>III</u>      |
|----|-----------------|-----------------|-----------------|
| A. | $1.5 \text{ V}$ | $1.5 \text{ V}$ | $4.5 \text{ V}$ |
| B. | $4.5 \text{ V}$ | $1.5 \text{ V}$ | $1.5 \text{ V}$ |
| C. | $1.5 \text{ V}$ | $4.5 \text{ V}$ | $4.5 \text{ V}$ |
| D. | $4.5 \text{ V}$ | $4.5 \text{ V}$ | $1.5 \text{ V}$ |

3. An object is thrown at  $45^\circ$  above horizontal. It reaches the highest point, and falls back to the original height. The air resistance is negligible. Which of the following statements is true?
- A. When the object is at the highest point, its speed is minimum (but not zero) and its acceleration is not zero.
  - B. When the object is at the highest point, its speed is minimum (but not zero) and its acceleration is zero.
  - C. When the object is at the highest point, its speed is zero and its acceleration is not zero.
  - D. When the object is at the highest point, its speed is zero and its acceleration is zero.
4. An object is released from rest, and it falls freely downward. Air resistance is negligible. After 1 s, what is the fallen distance? Take gravitational acceleration as  $g = 10 \text{ m/s}^2$ .
- A. 1 m
  - B. 2 m
  - C. 5 m
  - D. 10 m
5. An elevator is accelerating upward with a constant acceleration  $10 \text{ m/s}^2$ . A box of mass 1 kg is on the floor of the elevator. What is the magnitude of the force acted by the box on the elevator? Take gravitational acceleration as  $g = 10 \text{ m/s}^2$ .
- A. 0 N
  - B. 10 N
  - C. 20 N
  - D. 100 N
6. A coin is thrown vertically upward and get to its highest point. If the force on the coin due to air resistance is proportional to the speed of the coin, the magnitude of the acceleration of the coin during the upward motion
- A. remains unchanged.
  - B. is zero at the highest point.
  - C. is minimum at the highest point.
  - D. is maximum at the highest point.

3. 一物體以仰角  $45^\circ$  被拋出。它到達最高點，之後下跌到原本的高度。空氣阻力可以被忽略。以下哪一句句子是正確的？
- A. 當物件到達最高點時，它的速率達到最小值(但不是零)，它的加速度不是零。
  - B. 當物件到達最高點時，它的速率達到最小值(但不是零)，它的加速度是零。
  - C. 當物件到達最高點時，它的速率是零，它的加速度不是零。
  - D. 當物件到達最高點時，它的速率是零，它的加速度是零。
4. 一物體由靜止開始自由落下。空氣阻力可以被忽略。1 s後，物體的下落距離是多少？地心加速率是  $g = 10 \text{ m/s}^2$ 。
- A. 1 m
  - B. 2 m
  - C. 5 m
  - D. 10 m
5. 一升降機以恆加速度  $10 \text{ m/s}^2$  向上加速。一個質量為 1 kg 的盒子在升降機的地板上。盒子施加於升降機的力的量值是多少？地心加速率是  $g = 10 \text{ m/s}^2$ 。
- A. 0 N
  - B. 10 N
  - C. 20 N
  - D. 100 N
6. 一枚硬幣垂直地被拋起繼而達至最高點。如果作用在硬幣上的空氣阻力正比於硬幣的速率，那麼硬幣的加速度量值在向上的運動過程中
- A. 保持不變。
  - B. 在最高點等於零。
  - C. 在最高點達至最小值。
  - D. 在最高點達至最大值。

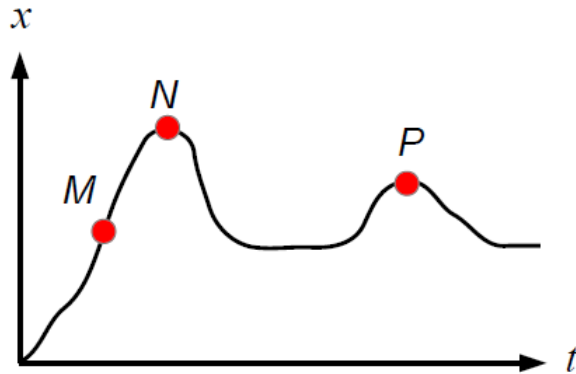


7. A boy stands at rest inside an elevator which is moving downward with a constant velocity. The magnitude of the force that the elevator floor exerts on the boy
- A. is smaller than that when the elevator is accelerating downward.
  - B. is larger than that when the elevator is accelerating downward.
  - C. is equal to that when the elevator is accelerating downward.
  - D. depends on the velocity of the elevator.
8. A box is at rest on an inclined plane. Which of the following about the frictional force acting on the box is correct?
- A. Its magnitude is larger than the weight of the box.
  - B. Its magnitude is equal to the weight of the box.
  - C. Its magnitude is smaller than the weight of the box.
  - D. It forms an action-reaction pair with the weight of the box.
9. The figure shows the position  $x$  of an object (moving along a straight line) as a function of time  $t$ . Which of the following description is correct?



- A. The speed at  $N$  is larger than the speed at  $M$ .
- B. The acceleration at  $N$  is zero.
- C. The kinetic energy at  $P$  is smaller than the kinetic energy at  $M$ .
- D. The force acting on the object at  $P$  is zero.

7. 一男孩站立在一架以均速下降的電梯內。電梯地面給予男孩的力的量值
- A. 少於當電梯向下加速時地面給予的力的量值。
  - B. 大於當電梯向下加速時地面給予的力的量值。
  - C. 相等於電梯向下加速時地面給予的力的量值。
  - D. 取決於電梯的速度。
8. 一個盒子靜放在一斜面上。以下哪項關於作用在盒子上的摩擦力是正確的？
- A. 它的量值大於盒子的重量。
  - B. 它的量值相等於盒子的重量。
  - C. 它的量值少於盒子的重量。
  - D. 它跟盒子的重量組成作用—反作用力對。
9. 下圖顯示一沿直線運動物件的位置  $x$  跟時間  $t$  的關係。以下哪項描述是正確的？



- A.  $N$  點的速率大於  $M$  點的速率。
- B.  $N$  點的加速度等於零。
- C.  $P$  點的動能少於  $M$  點的動能。
- D. 作用在物件的力在  $P$  點等於零。

10. A satellite is orbiting around the earth on the equatorial plane with an orbital period of 12 hours. The direction of motion of the satellite is opposite to the self-rotation of the earth. It is now 6 am in the morning and you see that the satellite is exactly above your head. When will the satellite be above your head again?

- A. 12 pm at noon
- B. 2 pm
- C. 6 pm
- D. 12 am at midnight

11. An object of mass 10 kg is moving on a smooth horizontal surface with velocity of  $5 \text{ ms}^{-1}$ . In order to change its velocity to  $10 \text{ ms}^{-1}$ , the work done would need to be

- A. 25 J
- B. 125 J
- C. 375 J
- D. 750 J

12. What happens to the wavelength and frequency of a ray of light if it passes from diamond into water?

- | <u><b>Wavelength</b></u> | <u><b>Frequency</b></u> |
|--------------------------|-------------------------|
| A. increases             | decreases               |
| B. decreases             | remains unchanged       |
| C. remains unchanged     | increases               |
| D. increases             | remains unchanged       |

13. An electric kettle takes 1 hour to boil a kettle of water when connected to a 220V source. What will be the time required to boil the same kettle of water when the electric kettle is connected to 110 V source? (Assume the resistance of the electric kettle remains unchanged.)

- A. 0.5 hour
- B. 1 hour
- C. 2 hours
- D. 4 hours

10. 一顆人造衛星在赤道平面以週期十二小時環繞地球公轉。衛星的運動方向跟地球的自轉方向相反。現在是早上六時，你看見衛星在你的正上方。衛星在那時會再在你正上方？

- A. 正午十二時
- B. 下午二時
- C. 下午六時
- D. 午夜十二時

11. 一質量為  $10\text{ kg}$  的物體在水平平滑面上以速度  $5\text{ ms}^{-1}$  運動。現要使其速度改變成  $10\text{ ms}^{-1}$ ，需作多少功？

- A.  $25\text{ J}$
- B.  $125\text{ J}$
- C.  $375\text{ J}$
- D.  $750\text{ J}$

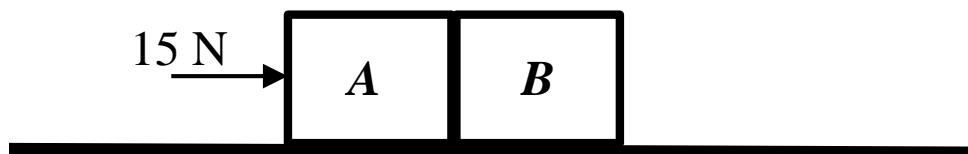
12. 如果一束光線從鑽石進入水，它的波長及頻率有何變化？

- |    | <u>波長</u> | <u>頻率</u> |
|----|-----------|-----------|
| A. | 增加        | 減少        |
| B. | 減少        | 不變        |
| C. | 不變        | 增加        |
| D. | 增加        | 不變        |

13. 一電熱水壺接駁  $220\text{ V}$  電源，需一小時把一壺水煮沸。現電熱水壺改為接駁  $110\text{ V}$  電源，那麼需時多久才可把同一壺水煮沸？（假設電熱水壺的電阻不變。）

- A. 半小時
- B. 一小時
- C. 兩小時
- D. 四小時

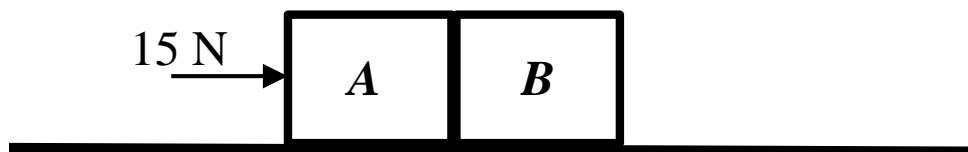
14.



Two blocks are placed on a smooth horizontal surface as shown above. The mass of block *A* is twice the mass of block *B*. A constant force of 15 N is applied to block *A* so that the two blocks move towards the right together. The force acting on *A* by *B* is

- A. 0 N
  - B. 5 N to the left
  - C. 5 N to the right
  - D. 15 N to the left
15. A metal object of mass 1 kg absorbs energy of 2000 J and hence its temperature rises by 5 °C. The specific heat capacity of the metal is
- A. 400 J kg °C<sup>-1</sup>
  - B. 10000 J kg<sup>-1</sup> °C
  - C. 400 J kg<sup>-1</sup> °C<sup>-1</sup>
  - D. 10000 J kg °C
16. A solute weighed 1.2 g is dissolved in 2.4 g of solvent. The concentration of the resulting solution is determined as 0.5 g/ml. Calculate the density of the solution.
- A. 0.8 g/ml
  - B. 1.2 g/ml
  - C. 1.5 g/ml
  - D. It cannot be calculated because the density of the solvent is not given.

14.



如上圖所示，兩石塊放置於水平平滑面上。石塊 **A** 的質量是石塊 **B** 質量的兩倍。  
一 **15 N** 的恆力作用於石塊 **A** 上，令致兩石塊一起向右方運動，那麼石塊 **B** 作用於石塊 **A** 的力是

- A. 0 N
- B. 5 N 向左
- C. 5 N 向右
- D. 15 N 向左

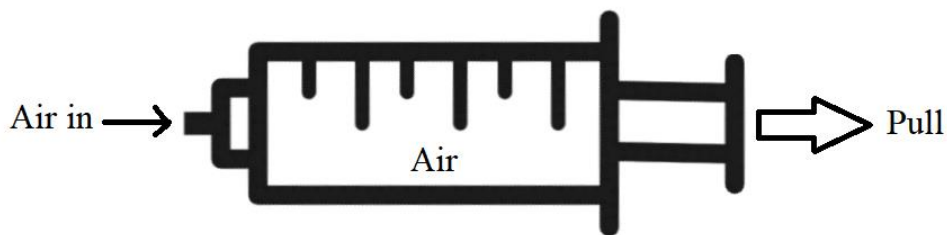
15. 一質量為 **1 kg** 的金屬物體吸收 **2000 J** 的能量，令它的溫度上升 **5 °C**，那麼金屬的比熱容量是

- A.  $400 \text{ J kg } ^\circ\text{C}^{-1}$
- B.  $10000 \text{ J kg}^{-1} ^\circ\text{C}$
- C.  $400 \text{ J kg}^{-1} ^\circ\text{C}^{-1}$
- D.  $10000 \text{ J kg } ^\circ\text{C}$

16. 質量為 **1.2 g** 的溶質溶解於 **2.4 g** 的溶劑中，所得溶液的濃度測得為 **0.5 g/ml**。  
計算該溶液的密度。

- A. **0.8 g/ml**
- B. **1.2 g/ml**
- C. **1.5 g/ml**
- D. 不能算出，這是因為沒有給出該溶劑的密度。

17. What happens when the piston of a syringe is pulled back to draw more air into it?



Sequence: (1)  $\rightarrow$  (2)  $\rightarrow$  ...  $\rightarrow$  (6).

$V$  = volume of air in the syringe,  $p$  = pressure of air in the syringe,

$N$  = number of gas molecules in the syringe.

" $\uparrow$ " = increases, " $\downarrow$ " = decreases.

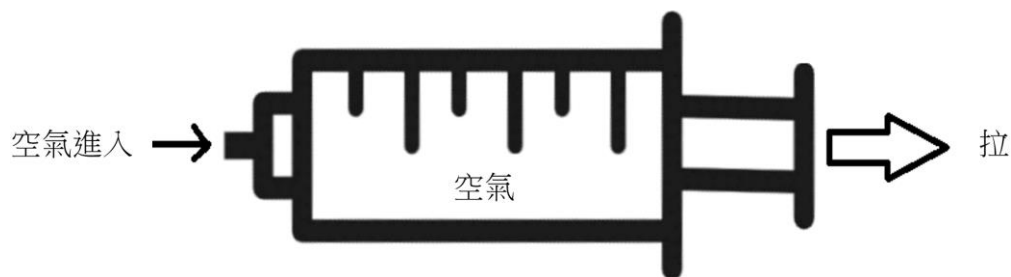
	(1)	(2)	(3)	(4)	(5)	(6)
A.	Capacity of the syringe increases.	$V \uparrow$	$p \downarrow$	Air enters into the syringe from outside.	$N \uparrow$	$p \uparrow$
B.		$V \uparrow$	$p \downarrow$		$p \uparrow$	$N \uparrow$
C.		$p \downarrow$	$V \uparrow$		$N \uparrow$	$p \uparrow$
D.		$p \downarrow$	$V \uparrow$		$p \uparrow$	$N \uparrow$

18. A sample of steel consists of two elements only: carbon and iron. Which of the following facts support the saying that "steel is a mixture of carbon and iron instead of an ionic compound of these two elements".

- (I) Steel is insoluble in water.
- (II) A steel bar can be bent without breaking.
- (III) At solid state, steel is an electrical conductor.

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

17. 當把氣筒的活塞往後拉，讓更多空氣流進氣筒，會發生什麼事情？



順序：(1) → (2) → ... → (6).

$V$  = 氣筒內空氣的體積， $p$  = 氣筒內空氣的壓強，

$N$  = 氣筒內氣體分子的數目。

“↑” = 增加，“↓” = 減少。

	(1)	(2)	(3)	(4)	(5)	(6)
A.	氣筒的容積增加。	$V \uparrow$	$p \downarrow$	空氣從外面流進氣筒。	$N \uparrow$	$p \uparrow$
B.		$V \uparrow$	$p \downarrow$		$p \uparrow$	$N \uparrow$
C.		$p \downarrow$	$V \uparrow$		$N \uparrow$	$p \uparrow$
D.		$p \downarrow$	$V \uparrow$		$p \uparrow$	$N \uparrow$

18. 一個鋼樣本含有兩種元素：碳和鐵。以下哪些事實支持「鋼是碳和鐵的混合物，卻不是由該兩元素所形成的離子化合物」的說法？

- (I) 鋼不溶於水。
- (II) 鋼條可被彎曲而不折斷。
- (III) 在固態時，鋼是電導體。

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



19. Consider following information of a molecule:

- (I) The molecular formula is  $\text{CON}_2\text{H}_4$ .
- (II) The C, O, and N atoms are connected in the following pattern:  $\text{N} \sim \text{N} \sim \text{O} \sim \text{C}$ , in which each “~” can be single, double, or triple bond.
- (III) It obeys the octet rule.

How many H atom(s) is/are bonded to the terminal N atom and C atom, respectively?

- A. 0 and 2
- B. 0 and 3
- C. 1 and 2
- D. 1 and 3

20. Which of the following interactions is/are involved in solid ammonium permanganate,  $[\text{NH}_4^+][\text{MnO}_4^-]$ ?

- (I) Metallic 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

21. In petrochemistry, big hydrocarbon molecules are broken down into smaller but more valuable molecules. Which of the following process(es) can be used for the breakdown?

- (I) Cracking
  - (II) Electrolysis
  - (III) Distillation
- 
- A. (I) only
  - B. (II) only
  - C. (III) only
  - D. All of them

19. 考慮某分子的以下資料：

(I) 分子式是  $\text{CON}_2\text{H}_4$ 。

(II) C、O 和 N 原子用以下方式連結：

$\text{N} \sim \text{N} \sim \text{O} \sim \text{C}$ ，其中每個「 $\sim$ 」可代表單鍵、雙鍵或叁鍵。

(III) 它遵從八隅體規則。

有多少個 H 原子是分別鍵合至終端的 N 原子及終端的 C 原子？

A. 0 和 2

B. 0 和 3

C. 1 和 2

D. 1 和 3

20. 高錳酸銨  $[\text{NH}_4^+][\text{MnO}_4^-]$  固體內涉及以下哪種作用力？

(I) 金屬鍵

(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

21. 在石油化學，巨大的烴分子被分解為較細小但卻更有用的分子。以下哪過程可用於該分解？

(I) 裂解

(II) 電解

(III) 蒸餾

A. 只有 (I)

B. 只有 (II)

C. 只有 (III)

D. 全部

22. Which of the following is a pair of isotopes? (X, Y, and Z may or may not be the same element.)

- A.  $^{114}_{54}\text{X}$  and  $^{115}_{55}\text{Y}$
- B.  $^{114}_{54}\text{X}$  and  $^{118}_{56}\text{Z}$
- C.  $^{115}_{55}\text{Y}$  and  $^{118}_{56}\text{Z}$
- D. None of the above

23. Q, R, X, and Y are metal elements. To arrange their reactivities, someone carried out the following experiments.

- (I) When metal Q is put into  $\text{R}^{2+}(\text{aq})$ , there is no reaction.
- (II) Heating oxide RO gives metal R. But there is no reaction when oxides XO and YO are heated separately.
- (III) When a mixture of oxide XO and metal Y is heated, metal X is obtained.

Which of the following is the correct ascending order of reactivities of these four metal elements?

- A.  $\text{Q} < \text{R} < \text{X} < \text{Y}$
- B.  $\text{Q} < \text{R} < \text{Y} < \text{X}$
- C.  $\text{R} < \text{Q} < \text{X} < \text{Y}$
- D.  $\text{R} < \text{Q} < \text{Y} < \text{X}$

24. Assume elements A, B, C, and D can only form stable  $\text{A}^{2+}$ ,  $\text{B}^{3+}$ ,  $\text{C}^{-}$  and  $\text{D}^{2-}$  ions, respectively. Which of the following chemical formulae for ionic compounds must be **wrong**?

- (I)  $\text{A}_2\text{BD}_4$
- (II)  $\text{A}_3\text{C}_2\text{D}_2$

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

22. 以下哪項是一對同位素？ (X、Y 和 Z 可能是或可能不是相同的元素。)

- A.  $^{114}_{54}\text{X}$  和  $^{115}_{55}\text{Y}$
- B.  $^{114}_{54}\text{X}$  和  $^{118}_{56}\text{Z}$
- C.  $^{115}_{55}\text{Y}$  和  $^{118}_{56}\text{Z}$
- D. 以上皆非

23. Q、R、X 和 Y 是金屬元素。為了把它們的活性排序，有人進行了下列實驗。

- (I) 當金屬 Q 放進  $\text{R}^{2+}(\text{aq})$  時，並不會起反應。
- (II) 把 RO (R 的氧化物) 加熱可得到金屬 R。但當把氧化物 XO 和 YO 分別加熱時，卻沒有反應。
- (III) 當把 XO (X 的氧化物) 和金屬 Y 共熱，可得到金屬 X。

以下何者是這四個金屬的活性由小到大的正確排序？

- A.  $\text{Q} < \text{R} < \text{X} < \text{Y}$
- B.  $\text{Q} < \text{R} < \text{Y} < \text{X}$
- C.  $\text{R} < \text{Q} < \text{X} < \text{Y}$
- D.  $\text{R} < \text{Q} < \text{Y} < \text{X}$

24. 假設元素 A、B、C 和 D 只能分別生成穩定的  $\text{A}^{2+}$ 、 $\text{B}^{3+}$ 、 $\text{C}^{-}$  和  $\text{D}^{2-}$  離子。

以下離子化合物的化學式，何者必定是錯誤的？

- (I)  $\text{A}_2\text{BD}_4$
- (II)  $\text{A}_3\text{C}_2\text{D}_2$

- A. 以上皆非
- B. 只有 (I)
- C. 只有 (II)
- D. 全部

25. "Methane ice" is a natural source of methane gas. Which one of the following statements about "methane ice" is correct?
- A. Methane gas is liquified by ice.
  - B. Methane gas is trapped in ice.
  - C. Methane gas is frozen to solid state which has a structure of ice.
  - D. It is a mixture of ice and an organic compound which react with each other to form methane slowly.

26. A sample of fertilizer contains 15% of potassium oxide ( $K_2O$ ). What is the mass of potassium in 2.0 g of the sample?
- A. 0.11 g
  - B. 0.21 g
  - C. 0.25 g
  - D. 0.30 g

27. In the following balanced chemical equation,



$a$ ,  $b$ ,  $c$ ,  $d$ , 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

25. 「甲烷冰」是甲烷氣體的天然資源。以下哪一項關於「甲烷冰」的陳述是正確的？

- A. 甲烷氣體被冰液化。
- B. 甲烷氣體被困於冰中。
- C. 甲烷氣體被冷凍成為具冰結構的固體。
- D. 這是冰與一個有機化合物的混合物，彼此反應，漸漸生成甲烷。

26. 一個肥料樣本含有 15% 的氧化鉀 ( $K_2O$ )。2.0 g 的這樣本中，鉀的質量是多少？

- A. 0.11 g
- B. 0.21 g
- C. 0.25 g
- D. 0.30 g

27. 在以下配平的化學方程式，



$a$ 、 $b$ 、 $c$ 、 $d$  和  $e$  是正整數並且成最簡整數比 (例如  $(a, b, c, d, e) = (1, 1, 2, 2, 3)$  是最簡整數比，但  $(a, b, c, d, e) = (2, 2, 4, 4, 6)$  則否)。 $c$  的數值是多少？

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

28. Which of the following is/are correct concerning  $(\text{NH}_4)_2\text{CO}_3(\text{aq})$ ?

- (I) When an acid solution is added, colourless bubbles are given out.
- (II) When an alkaline solution is added, a gas which turns moistened pH paper into orange/red is given out.

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

29. 1 kg of water is heated from  $25\text{ }^\circ\text{C}$  to  $95\text{ }^\circ\text{C}$  by burning 300 g of a fuel. How much heat is given out by burning 1 g of the fuel? Given: specific heat capacity of water =  $4.2\text{ J g}^{-1}\text{ }^\circ\text{C}^{-1}$ .

- A. 980 J
- B. 730 J
- C. 480 J
- D. 240 J

30. A scientist received a mixture of gases X (boiling point:  $-200\text{ }^\circ\text{C}$ ) and Y (boiling point:  $-100\text{ }^\circ\text{C}$ ) in a container. He carried out the following procedure to separate the two gases.

- (I) Cooled the container to  $-150\text{ }^\circ\text{C}$ .
- (II) Pumped out the gas portion.
- (III) Changed the temperature of the container so that the content remained in the container became gas.

Which gas was pumped out in Step (II) and how was the temperature of the container changed in Step (III)?

	<u><b>Gas pumped out in Step (II)</b></u>	<u><b>How the temperature was changed in Step (III)</b></u>
A.	X	Increased
B.	X	Decreased
C.	Y	Increased
D.	Y	Decreased

28. 以下哪項有關  $(\text{NH}_4)_2\text{CO}_3(\text{aq})$  是正確的？

- (I) 當加入酸性溶液，有無色氣體釋出。
- (II) 當加入鹼性溶液，會釋出令濕潤 pH 試紙轉為橙色/紅色的氣體。

- A. 以上皆非
- B. 只有 (I)
- C. 只有 (II)
- D. 全部

29. 通過燃燒 300 g 的某燃料，可把 1 kg 的水由 25 °C 加熱至 95 °C。那麼燃燒 1 g 的這燃料可釋出多少熱？ 已知水的比熱容 =  $4.2 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$ 。

- A. 980 J
- B. 730 J
- C. 480 J
- D. 240 J

30. 一名科學家收到一個盛載氣體 X (沸點：-200 °C) 和 氣體 Y (沸點：-100 °C) 混合物的容器。他進行下列步驟來把這兩氣體分離。

- (I) 將容器降至 -150 °C。
- (II) 泵走氣體部分。
- (III) 將容器的溫度改變，讓容器餘下的內含物變為氣體。

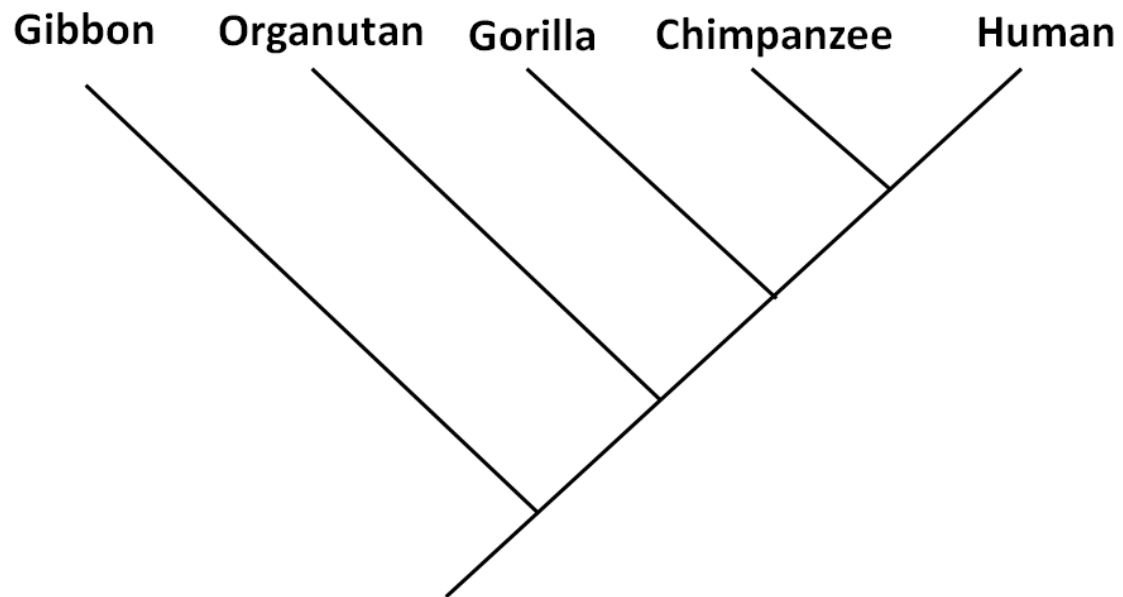
在步驟 (II) 泵走了哪一氣體以及在步驟 (III) 容器的溫度怎樣改變？

<u>在步驟 (II)</u> <u>泵走的氣體</u>	<u>在步驟 (III) 怎樣改變</u> <u>容器的溫度</u>
A. X	增加
B. X	減少
C. Y	增加
D. Y	減少



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

Below shows an evolutionary tree of apes and human.

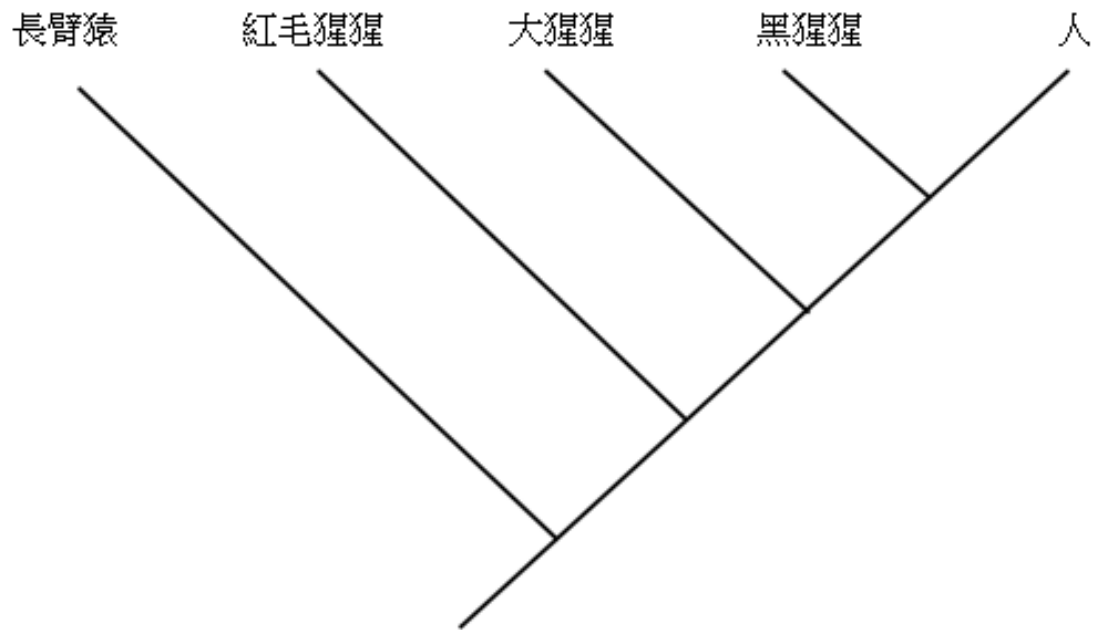


31. Which of the following is/are **CORRECT**?

- A. Human shares a common ancestor with Chimpanzee but not Gibbon.
- B. In terms of evolutionarily relatedness, Organutan and Gorilla show a closer relationship than Organutan and Human do.
- C. Human and Chimpanzee probably have less DNA sequence differences than Human and Organutan do.
- D. More than one of the above.

根據以下資料，回答第 31 題及第 32 題。

下圖顯示猿類和人的進化樹。

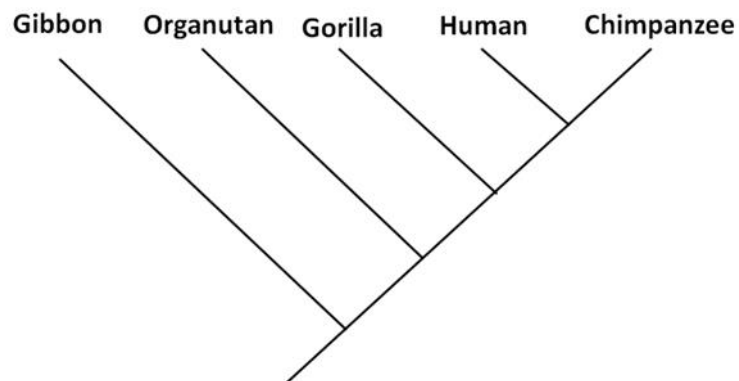


31. 以下哪項是正確的？

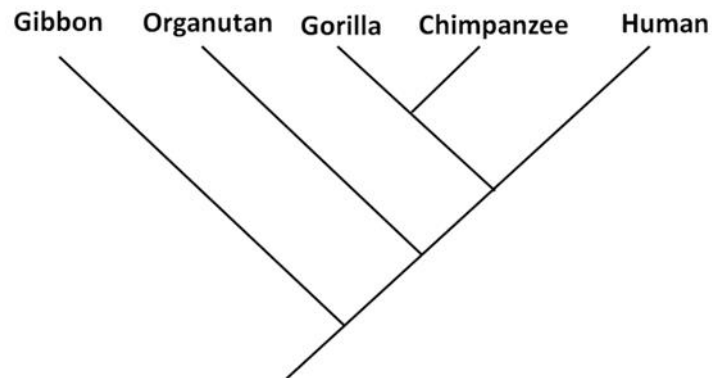
- A. 人與黑猩猩具有共同的祖先，人與長臂猿則否。
- B. 就進化的相關程度而言，大猩猩比人更接近紅毛猩猩。
- C. 人和黑猩猩的 DNA 序列差異很可能少於人和紅毛猩猩的 DNA 序列差異。
- D. 多於以上一項。

32. Which of the following trees show(s) an evolutionary story different from the original tree?

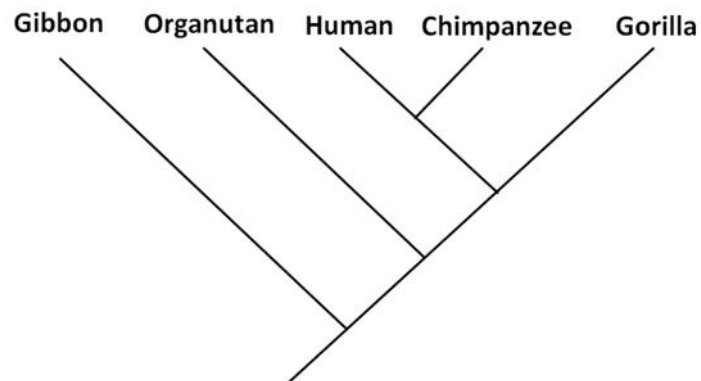
(I)



(II)



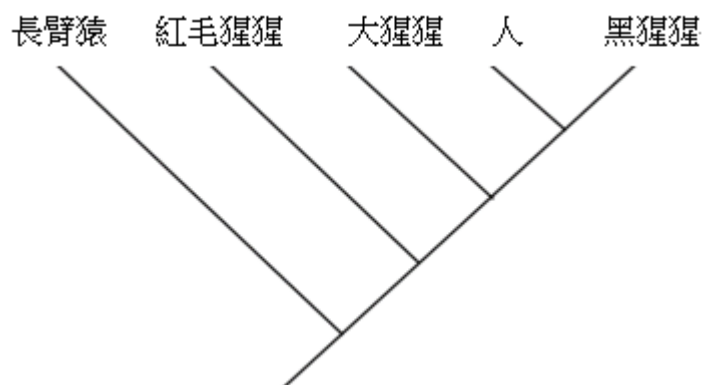
(III)



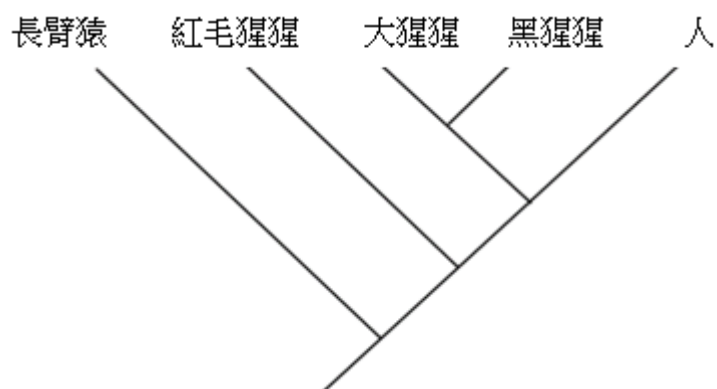
- A. (I) only.
- B. (II) only.
- C. (III) only.
- D. More than one of the above.

32. 以下進化樹所顯示的進化途徑，哪個與原來的進化樹不同？

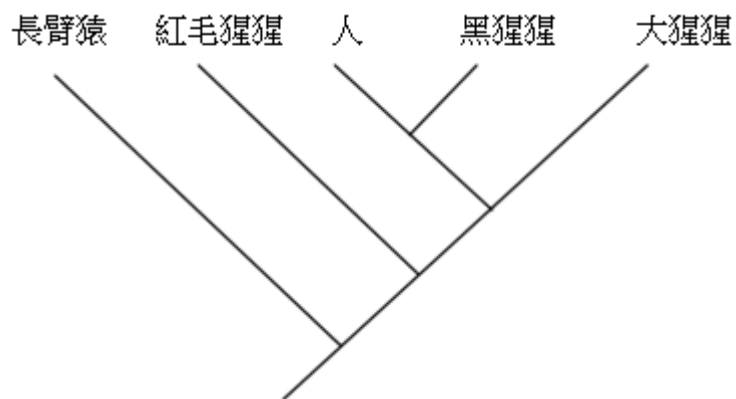
(I)



(II)



(III)

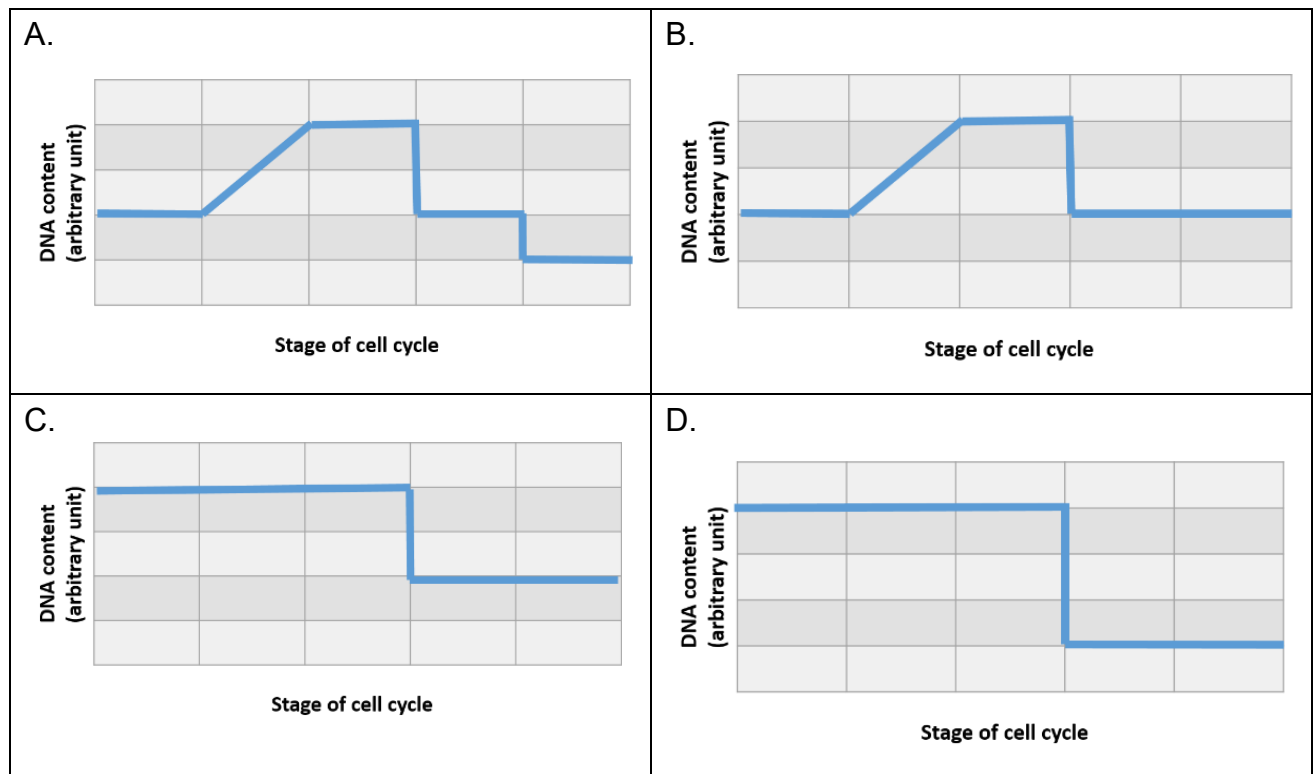


- A. 只有 (I)
- B. 只有 (II)
- C. 只有 (III)
- D. 多於以上一項

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

Meiosis is a type of cell division which results in the formation of four daughter cells from a mother cell. Each of the daughter cells carries half of DNA content of the mother cell.

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 unit), x-axis: Stage of cell cycle)



34. Meiosis is involved to produce

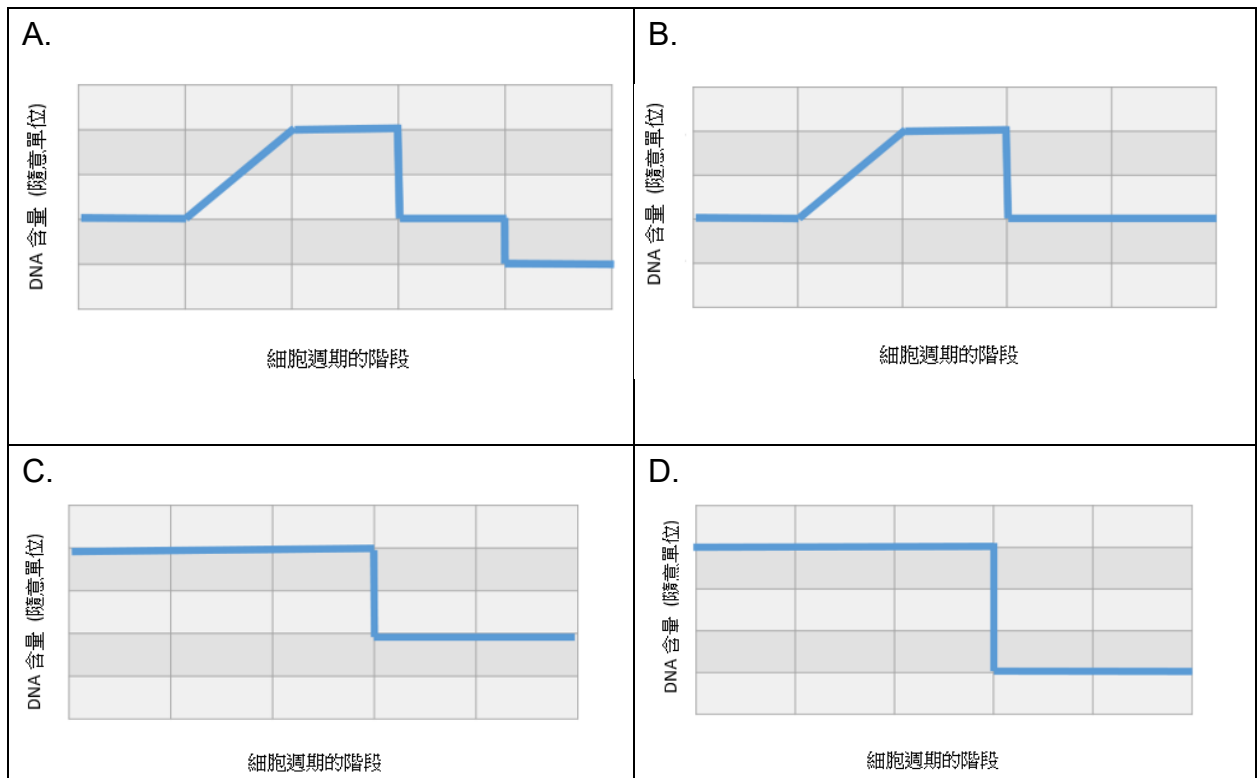
- (I) Sperm cells
- (II) Ovules in plant ovary
- (III) Stem cells

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

根據以下資料，回答第 33 題及第 34 題。

減數分裂是一種細胞分裂，其結果是一個母細胞形成四個子細胞，每個子細胞的 DNA 含量是母細胞的一半。

33. 以下哪圖顯示新形成的母細胞至新形成的子細胞期間，其 DNA 含量的正確變化？  
(y 軸: DNA 含量 (隨意單位)，x 軸: 細胞週期的階段)



34. 減數分裂涉及產生

- (I) 精子細胞
- (II) 植物子房內的胚珠
- (III) 幹細胞

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

35. Which of the following statements is/are **correct**?

- (I) Transcription takes place in nucleus.
- (II) Transcription takes place in cytoplasm.
- (III) mRNA is mobilised from nucleus to cytoplasm.
- (IV) mRNA is mobilised from cytoplasm to nucleus.

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

36. Which of the following statements is/are **incorrect**?

- (I) Amino acids are the basic units of protein.
- (II) mRNA are the basic units of protein.
- (III) Translation takes place in cytoplasm.
- (IV) Translation begins in nucleus and ends in cytoplasm.

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

根據以下資料，回答第 35 題及第 36 題。

下圖顯示分子生物學的中心法則：



在細胞核中，以染色體形式貯存的 DNA 不能穿越核孔(核膜上的小孔)。以 DNA 為模板進行轉錄，產生 mRNA。在細胞質中，mRNA 經轉譯而令氨基酸被組合為蛋白質。

35. 以下哪項陳述是正確的？

- (I) 轉錄在細胞核內進行。
- (II) 轉錄在細胞質中進行。
- (III) mRNA 由細胞核移動至細胞質。
- (IV) mRNA 由細胞質移動至細胞核。

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

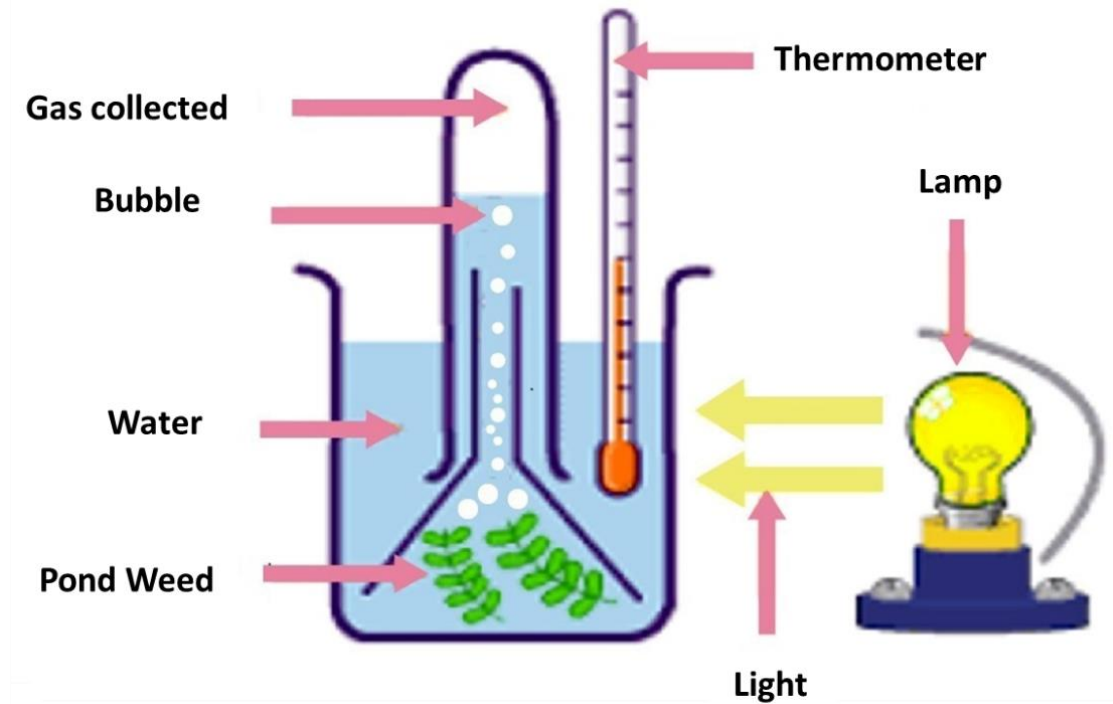
36. 以下哪項陳述是不正確的？

- (I) 氨基酸是蛋白質的基本單位。
- (II) mRNA 是蛋白質的基本單位。
- (III) 轉譯在細胞質中進行。
- (IV) 轉譯在細胞核內開始，在細胞質中結束。

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



Answer **Q37** and **Q38** based on the following information.



37. When the lamp (incandescent bulb) is moved significantly closer to the beaker, which of the following will increase?

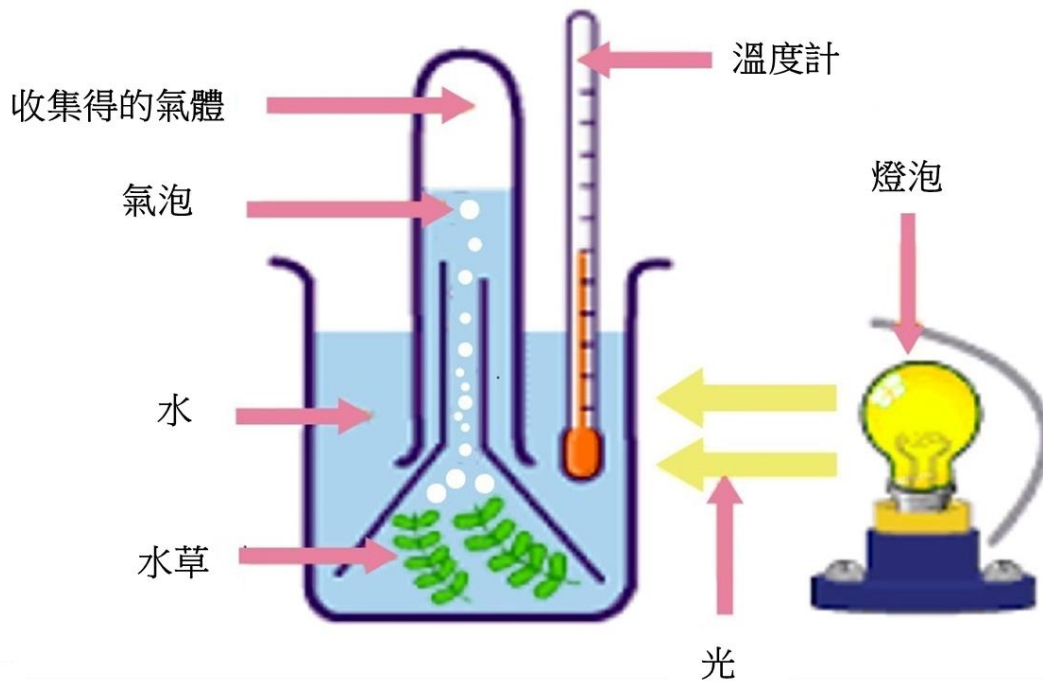
- (I) Photosynthetic rate
- (II) Respiration rate
- (III) Temperature

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

38. The gas produced by the pond weed was collected in the test tube as shown. When a glowing splint was placed into the test tube, it re-ignited. What is the conclusion that one can be deduced solely based on the glowing splint test?

- A. The gas collected is flammable.
- B. The gas collected is non-flammable.
- C. The gas collected is oxygen.
- D. The gas collected is carbon dioxide.

根據以下資料，回答第 37 題和第 38 題。



37. 當燈泡(白熾燈泡) 被移至相當接近燒杯時，以下哪項會增加？

- (I) 光合作用速率
- (II) 呼吸作用速率
- (III) 溫度

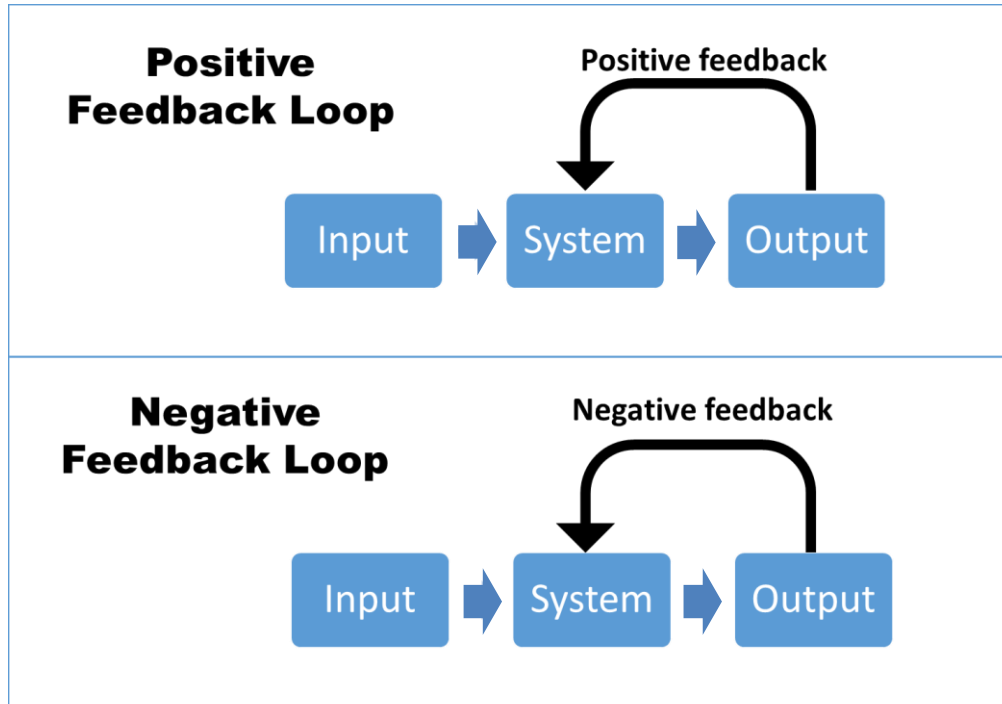
- A. 只有 (I)
- B. 只有 (I) 和 (II)
- C. 只有 (I) 和 (III)
- D. 全部均是

38. 如圖所示，以試管收集水草所產生的氣體。將帶餘燼木條置於試管中，會令木條重燃。單憑餘燼木條試驗，可以推斷出什麼結論？

- A. 所收集的氣體是易燃的。
- B. 所收集的氣體是不易燃的。
- C. 所收集的氣體是氧。
- D. 所收集的氣體是二氧化碳。

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.



39. Negative feedback loops are important in biological systems because they allow the system to maintain homeostasis or a more or less stable state. Which of the following processes is **NOT** an example of negative feedback loop in biological systems?

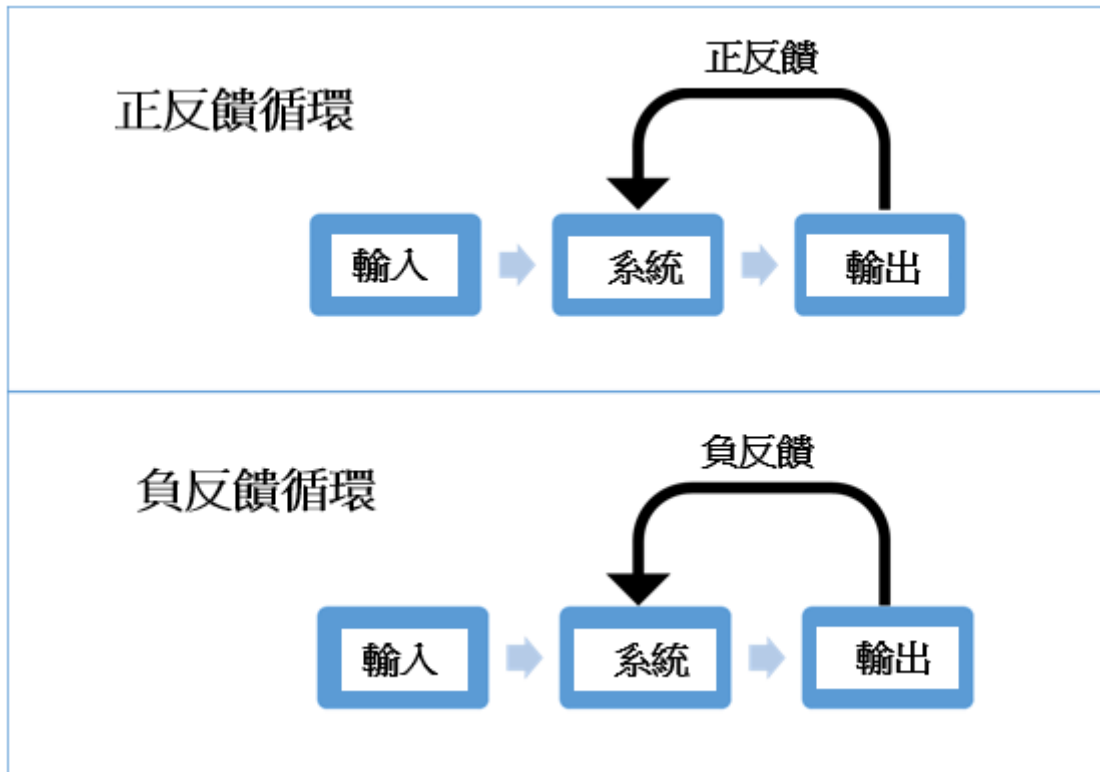
- A. Maintaining constant body temperature in mammals and birds.
- B. Regulation of the population sizes of predator and prey in ecosystems.
- C. Osmoregulation in some aquatic organisms.
- D. None of the above.

40. Positive feedback reactions will function to facilitate the progress of irreversible processes. The following processes are examples of positive feedback loops **except**:

- A. blood clotting.
- B. ripening of fruits.
- C. diffusion of solutes within a cell.
- D. child birth.

反饋反應常見於生物系統。根據所涉及的反饋反應的類別，通常由生物過程連結形成的反饋循環可分為正循環或負循環。在正反饋循環中，系統的輸出會擴大系統的反應；而負反饋循環的輸出則會抑制該系統。

根據下圖，回答第 39 題及第 40 題。



39. 負反饋循環對生物系統是重要的，因為它們讓系統得以維持體內平衡或處於大致穩定的狀態。以下哪個過程不是生物系統內負反饋循環的例子？

- A. 哺乳類和鳥類維持恆定的體溫。
- B. 生態系中調節捕食者和獵物的種群大小。
- C. 某些水生生物的滲透調節。
- D. 以上都不是。

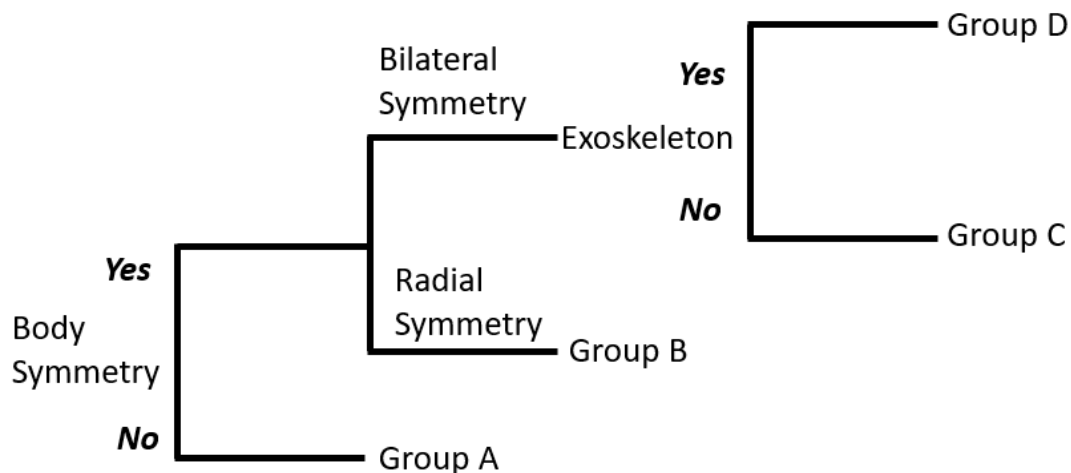
40. 正反饋反應運作時，會促使不可逆過程的進行。以下過程是正反饋循環的例子，除了

- A. 凝血。
- B. 果實催熟。
- C. 細胞內容質的擴散。
- D. 分娩。

41. Which of the following processes can be found only in some prokaryotic cells (for example, bacteria) but not in eukaryotic cells?

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

Answer **Q42** and **Q43** with reference to the following figure, which shows the grouping of some animal groups by using a dichotomous key.



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

- A. Animals in Group A is most distantly related in phylogeny to other groups.
- B. Animals in Group B do not have exoskeleton.
- C. Animals in Group C and Group D are more closely related in phylogeny to each other than to animals in Group B.
- D. All of the above statements is true.

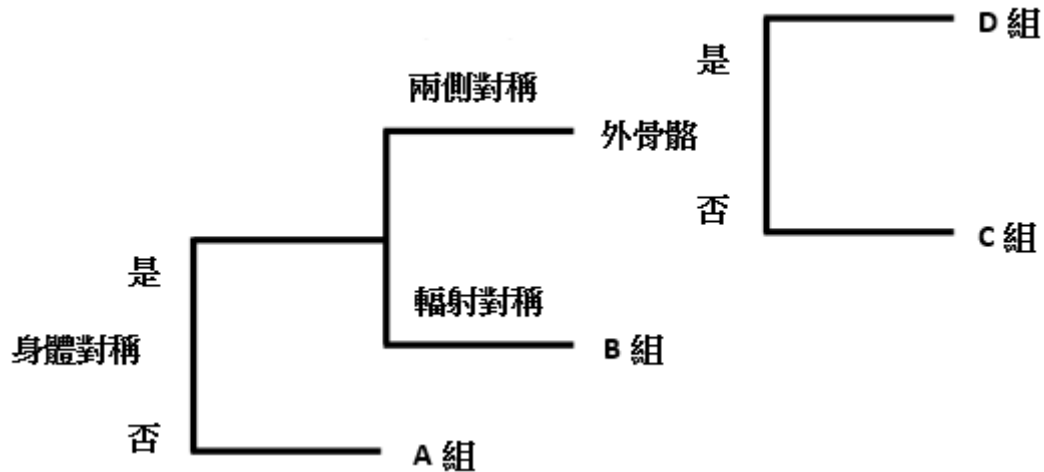
43. Examples of animals from Group A and Group D are respectively:

- A. sponges and earthworms.
- B. sponges and crabs.
- C. corals and spiders.
- D. None of the above combinations is correct.

41. 以下哪個過程只在一些原核細胞(例如細菌)內發生，但不能在真核細胞內發生？

- A. 缺氧呼吸
- B. 固氮作用
- C. 光合作用
- D. 胞吞作用

下圖顯示以二叉式檢索表來將一些動物組別進行分組。參考下圖，回答第 42 題及第 43 題。



42. 以下哪項陳述最可能是不正確？

- A. A 組動物與其他組別的親緣距離最遠。
- B. B 組動物沒有外骨骼。
- C. C 組和 D 組動物間的親緣關係較各自與 B 組動物的親緣關係密切。
- D. 以上陳述皆正確。

43. A 組和 D 組動物的例子分別是：

- A. 海綿和蚯蚓。
- B. 海綿和蟹。
- C. 珊瑚和蜘蛛。
- D. 以上組合無一正確。

44. When a fluorescent gene from a jellyfish is incorporated into zebrafish, the fish will emit blue light in presence of ultraviolet light, which of the following statements regarding this phenomenon is most likely to be **TRUE**?
- A. The jellyfish and zebrafish share a common ancestor.
  - B. Most enzymes in the zebrafish have the same amino acid sequences as the enzymes in jellyfish.
  - C. Both transcription and translation work under the same mechanisms in both species.
  - D. None of the above statements is true.
45. Which of the following pairs of structures are structurally homologous but functionally analogous?
- A. Pectoral fins of fish and wings of birds.
  - B. Lower limbs of humans and hindlimbs of dogs.
  - C. Flippers of dolphins and forelimbs of penguins.
  - D. Upper limbs of humans and wings of bats.

44. 將取自一隻水母的螢光基因併接到斑馬魚中，該條斑馬魚在紫外光下會發出藍光。以下哪項有關這個現象的陳述最可能是正確？
- A. 該隻水母和該條斑馬魚具有共同的祖先。
  - B. 斑馬魚體內的大部份酶的氨基酸序列與水母體內的酶的氨基酸序列相同。
  - C. 兩個物種體內，均以相同的機制進行轉錄和轉譯。
  - D. 以上陳述無一正確。
45. 以下哪項配對的結構上屬於同源結構而在功能上是同功結構？
- A. 魚類的胸鰭和鳥類的翼。
  - B. 人類的下肢和狗的後肢。
  - C. 海豚的鰭肢和企鵝的前肢。
  - D. 人類的上肢和蝙蝠的翼。





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

## International Junior Science Olympiad 2021 - Hong Kong Screening

### Answer

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