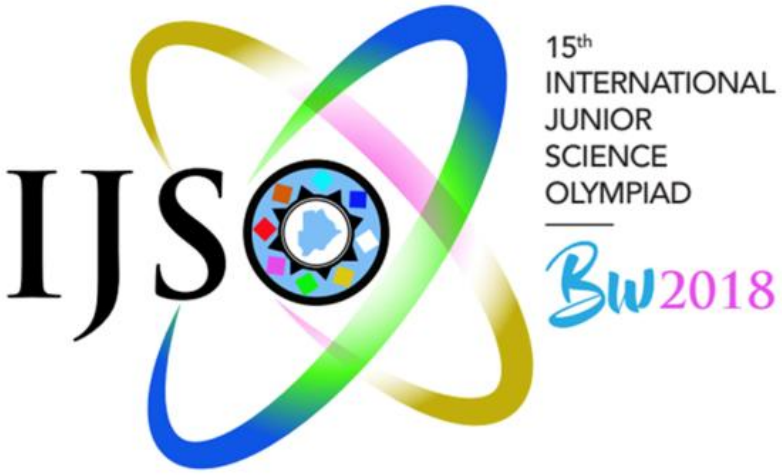
15TH INTERNATIONAL JUNIOR SCIENCE OLYMPIAD

IJSO-2018



Discovery, Innovation and Environment

Multiple Choice Competition

– Exam Sheet –

December 4, 2018

Do NOT turn to next page

before a whistle is blown.

Otherwise, you will receive a penalty.

1. You have 10 minutes to read "EXAMINATION RULES", "EXAM INSTRUCTIONS", and "CALCULATOR INSTRUCTIONS" on pages 1 - 3.

2. Do NOT start answering the questions before the"START"whistle! Otherwise, you will receive a penalty.

QUESTIONS

EXAMINATION RULES

1. You are NOT allowed to bring any personal items into the examination room, except for personal medicine or approved personal medical equipment.
2. You must sit at your designated desk.
3. Check the stationery items (pen, calculator, and rough book) provided by the organizers.
4. Do NOT start answering the questions before the "START" whistle.
5. You are NOT allowed to leave the examination room during the examination except in an emergency in which case you will be accompanied by a supervisor/volunteer/invigilator.
6. Do NOT disturb other competitors. If you need any assistance, you may raise your hand and wait for a supervisor to come.
7. Do NOT discuss the examination questions. You must stay at your desk until the end of the examination time, even if you have finished the exam.
8. At the end of the examination time you will hear the "STOP" whistle. Do NOT write anything more on the answer sheet after this stop whistle. Arrange the exam, answer sheets, and the stationary items (pen, calculator, and rough book) neatly on your desk. Do NOT leave the room before all the answer sheets have been collected.

QUESTIONS

EXAM INSTRUCTIONS

1. After the "START" whistle, you will have 3 hours to complete the exam.

2. ONLY use the pen provided by the organizers (not pencil).

3. NOW write your name, code, country and signature in your answer sheet (one page). Raise your hand, if you do not have the answer sheet.

4. Read each problem carefully and indicate your answer on the answer sheet using a cross (as shown below). There is only one right answer for each problem.

   Example : (A) is your answer.

1	A	B	C	D

5. If you want to change your answer, circle your first answer and then indicate your new answer using a cross (as shown below). You can only make ONE correction per question.

   Example : (A) is your first answer and (D) is your final answer.

1	A	B	C	D

6. Only the answer sheet will be evaluated. Before writing your answers on the answer sheet, use the rough book provided.

7. Point rules

Correct answer	: + 1 point
Wrong answer	: – 0.25 point
No answer	: no point

8. The total number of questions is 30. Check that you have a complete set of the test questions (19 pages, page 5 – page 19) after the "START" whistle is blown. Raise your hand, if you find any missing sheets.

QUESTIONS

INSTRUCTIONS FOR CALCULATOR

1. Turning on: Press [ON/C].

2. Turning off: Press [2ndF] [ON/C].

3. Clearing data: Press [ON/C].

4. Addition, subtraction, multiplication, and division

Example 1) $45 + \frac{285}{3}$

[ON/C] *45* [+] *285* [÷] *3* [=] *140.*

Example 2) $\frac{18+6}{15-8}$

[ON/C] [(] *18* [+] *6* [)] [÷] [(] *15* [−] *8* [)] [=] *3.428571429*

Example 3) $42 \times (-5) + 120$

[ON/C] *42* [×] *5* [+/−] [+] *120* [=] *-90.*

[ON/C] *42* [×] [(] [−] *5* [)] [+] *120* [=] *-90.*

5. Exponential

Example 1) 8.6^{-2}

[ON/C] *8.6* [y^x] *2* [+/−] [=] *0.013520822*

Example 2) 6.1×10^{23}

[ON/C] *6.1* [×] *10* [y^x] *23* [=] *6.1 x* 10^{23}

6. To delete a number/function, move the cursor to the number/function you wish to delete, then press [DEL]. If the cursor is located at the right end of a number/function, the [DEL] key will function as a back space key.

QUESTIONS

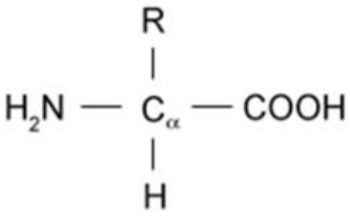
Do NOT turn to next page Before the"START"whistle is blown.

Otherwise, you will receive a penalty.

QUESTIONS

BIOLOGY

1. Amino acids are groups of organic molecules that are building blocks of proteins. The picture below shows a typical amino acid structure. Amino acids serve as buffers to maintain cell pH in the body. Which parts of an amino acid gives it the *pH* buffering properties?



A. Amino group and hydroxyl group
B. Peptide bond and carboxyl group
C. Carboxyl group and hydroxyl group
D. Amino group and carboxyl group

2. In the DNA sequence shown below, the normal Guanine (G) in the top strand was replaced by the mutant enol form G* before replication. This mutant enol form binds to Thymine (T) instead of Cytosine (C).

A A C A T T C G C C C
T T G T A A G C G G G

What would be the proportion of mutant (different from the original strand shown above) progeny in the second filial (F_2) generation?

A. 1/2
B. 1/3
C. 1/4
D. 1/5

QUESTIONS

3. An ecologist driving along the banks of the Chobe River, Botswana, observes little white egrets (*Bubulcus ibis*) sitting on the back of a hippopotamus (*Hippopotamus amphibius*). The hippopotamus did not chase the birds away. The ecologist took out his binoculars and observed what was happening. He recorded that the birds were picking ticks from the hippo's skin.



Source: Flickr.com/photos/38504899@N08/4178471716

The symbiotic interaction between the hippo and the egrets could be described as

A. Commensalism
B. Parasitism
C. Mutualism
D. Amensalism

4. Oxygen consumption can be used as a measure of metabolic rate because oxygen is

A. Required by all living organisms
B. Required to break down lactic acid that is produced in muscles
C, Necessary for Adenosine Tri-Phosphate (ATP) synthesis by oxidation
D. Necessary to replenish glycogen levels

5. Embryonic development is a complex multi-step process that involves transition from single cellularism to multicellularism. In animals, all of the following are associated with embryonic development except

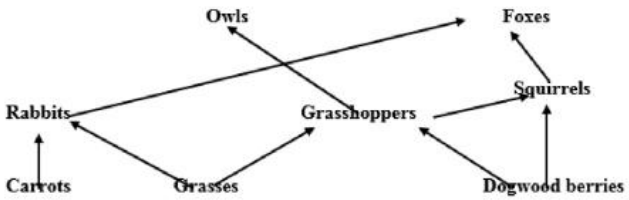
A. Migration of cells to specific areas
B. Formation of germ layers
C. Activation of all the genes in each cell
D. Inductive tissue interactions

QUESTIONS

6. Nitrogen accounts for approximately 79% of air. However, in this form it is inaccessible to most organisms. Atmospheric nitrogen has to be converted into a usable form in the soil by nitrogen fixation for plant growth. The nitrogen fixation mainly occurs by

A. Lightning
B. Biological processes
C. Volcanic eruptions
D. Haber-Bosch process

7. The pesticide Dichlorodiphenyltrichloroethane (DDT) was widely used between 1940 and 1960 to kill mosquitoes that transmit the malaria pathogen. Though useful, the pesticide was found to be persistent, meaning it does not degrade easily in the environment. Supposing DDT was sprayed on grasses to eradicate mosquitoes, which organisms in the food web will have the highest concentration of DDT within its tissues?



A. Rabbits
B. Owls
C. Squirrels
D. Foxes

8. Consider the following statements regarding bacterial, animal and plant cells:

(i) Animal and plant cells have a nucleoid.
(ii) Peptidoglycan is the major cell wall component in bacteria.
(iii) Bacterial cell has no cell wall.
(iv) Animal and plant cells generate ATP within the mitochondria.
(v) The main constituent of plant cell walls is a polysaccharide called lignin.

(vi) Bacterial cell generates ATP within the cytoplasm.

Which of the above statements are correct?
A. (i), (iii) and (vi)
B. (i), (iv) and (v)
C. (ii), (iv) and (vi)
D. (ii), (iv) and (v)

9. Leaves have air spaces in between mesophyll cells, as opposed to being completely occupied by cells or water. How are the air spaces useful for CO_2 diffusion?

A. They increase surface area for CO_2 absorption
B. Allow for faster diffusion of CO_2
C. If there were no air spaces between the cells, the amount of CO_2 would be the rate limiting factor in photosynthesis
D. All of the above

10. Guttation (picture below) in small plants happens at night and is due to osmosis. Which of the following statements describes how the process of guttation occurs?



https://twitter.com/cairotango/status/332246248818106368

A. Positive pressure generated in the roots pushes water out of the xylem in the leaves
B. Water accumulates in the leaves because evaporation happens slower than transpiration
C. Water is pulled up in large quantities to leaves because of an increase in solute concentrations in the leaves
D. Water from dew gathers on the surface of plant leaves

QUESTIONS

CHEMISTRY

11. What is the mass percentage of nitrogen in the following active compounds present in fertilizers; (i) Ammonium Nitrate and (ii) Ammonium Sulfate

	(i) Ammonium Nitrate	(ii) Ammonium Sulfate
A.	35	40
B.	32	21
C.	35	21
D.	21	35

12. The electronic configurations of ions in quick lime (calcium oxide) are;

	Cation	*Anion*
A.	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$	$1s^2\ 2s^2\ 2p^6$
B.	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$	$1s^2\ 2s^2\ 2p^6\ 3s^2$
C.	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$	$1s^2\ 2s^2\ 2p^6$
D.	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4\ 4s^2$	$1s^2\ 2s^2\ 2p^4\ 3s^2$

13. Carat is a unit of weight, commonly abbreviated as "ct". It is used to express the weight of diamonds. Lesedi La Rona ["Our Light" in Tswana language], the second-largest gem-quality diamond ever from Botswana weighed in at 1109 carats, (1 carat = 0.2 g). How many carbon atoms are in the Lesedi La Rona diamond?

A. 1.1×10^{23}
B. 1.1×10^{25}
C. 1.1×10^{26}
D. 1.3×10^{26}

QUESTIONS

14. The following redox equation occurs in an aqueous solution:

$KMnO_4 + KCl + H_2SO_4 \rightarrow MnSO_4 + K_2SO_4 + H_2O + Cl_2$

What is the stoichiometric coefficient for chlorine (Cl_2) when the equation is balanced with the smallest whole number coefficients?

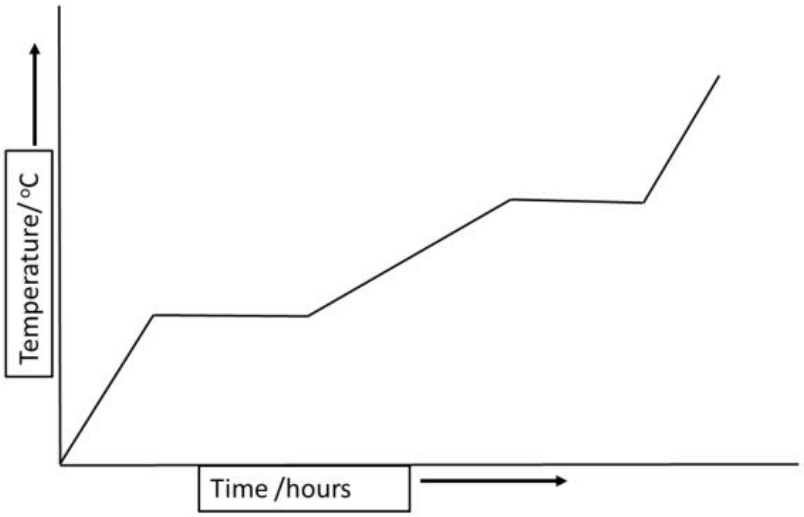
A. 1
B. 3
C. 5
D. 8

15. Equal volumes of 0.1 M $(NH_4)_2SO_4$ and 0.1 M NaI are mixed. Which statement describes what happens?

A. NH_4I precipitates when the solutions are mixed
B. Na_2SO_4 precipitates when the solutions are mixed
C. Both compounds remain in solution when the two solutions are mixed
D. Both NH_4I and Na_2SO_4 precipitate

QUESTIONS

16. The diagram shows how the temperature of a particular substance changes when it is heated at a uniform rate from a temperature below its freezing point to above its boiling point.



Consider the following statements:

I. The heat capacity of the solid form of the substance is larger than its liquid form.

II. The heat capacity of the vapor is larger than that of liquid.

Which of the following statement is correct?

A. Statement I and statement II are correct

B. Statement I is correct, while statement II is incorrect

C. Statement I is false while statement II is correct.

D. Both statement I and statement II are incorrect.

QUESTIONS

17. Use the following data to calculate the enthalpy of combustion for one mole of ethane, C_2H_6.

$$2C_2H_6\,(g) + 7O_2\,(g) \rightarrow 4CO_2\,(g) + 6H_2O\,(l)$$

$2C_2H_2\,(g) + 5O_2\,(g) \rightarrow 4CO_2\,(g) + 2H_2O\,(l)$	$\Delta H = -2600$ kJ
$C_2H_2\,(g) + 2H_2\,(g) \rightarrow C_2H_6\,(g)$	$\Delta H = -311$ kJ
$2H_2\,(g) + O_2\,(g) \rightarrow 2H_2O\,(g)$	$\Delta H = -484$ kJ
$H_2O\,(l) \rightarrow H_2O\,(g)$	$\Delta H = 44$ kJ

A. –1517 kJ/mol

B. –2772 kJ/mol

C. –3122 kJ/mol

D. –1561 kJ/mol

18. X is a symbol for a particular element. Which one of the following formulas is most likely incorrect (is NOT a reasonable formula)

A. X_2S_3

B. $X_2(NO_3)_3$

C. XCl_3

D. X_2O_3

19. Consider the equilibrium reaction: $3ClO^-(aq) \leftrightarrow ClO_3^-(aq) + 2Cl^-(aq)$. The equilibrium constant $K_c = 3.2 \times 10^3$. The following concentrations are present: $[Cl^-] = 0.50$ mol/L, $[ClO_3^-] = 0.32$ mol/L, $[ClO^-] = 0.24$ mol/L.

Is the mixture at equilibrium and, if not, in which direction will the reaction proceed?

A. The system is at equilibrium.

B. The system is not at equilibrium; reaction will proceed left to right.

C. The system is not at equilibrium; reaction will proceed right to left.

D. The system cannot reach equilibrium since the ClO_3^- and Cl^- concentrations are not in the stoichiometric ratio.

20. Manganese (III) fluoride can be prepared from the following reaction:

$2MnI_2\ (s) + 13F_2\ (g) \rightarrow 2MnF_3\ (s) + 4IF_5\ (l)$

Given that 0.050 mol of $MnI_2\ (s)$ is made to react with excess $F_2\ (g)$. What mass of MnF_3 will be obtained if the percentage yield is 75%?

A. 4.2 g.
B. 5.6 g
C. 7.5 g
D. 2.8 g

QUESTIONS

PHYSICS

21. A sample of oxygen gas occupies a volume of 0.250 m^3 at a pressure of 125 kPa. Assuming a constant temperature, what volume would the gas occupy at a pressure of 250 kPa?

A. 7.000 m^3

B. 0.125 m^3

C. 2.130 m^3

D. 0.438 m^3

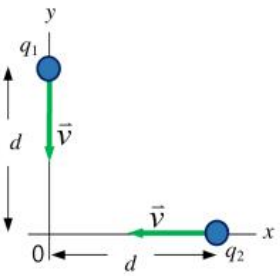
22. Two point charges q_1 and q_2, are each moving in vacuum towards the origin. At the instant shown q_1 is at position (0, d) and q_2 is at (d, 0). What is the magnitude of the electric force between the two charges? (Note $k = \frac{1}{4\pi\varepsilon_o}$).

A. $\frac{q_1 q_2}{4\pi\varepsilon_o d}$

B. $\frac{q_1 q_2}{8\pi\varepsilon_o d}$

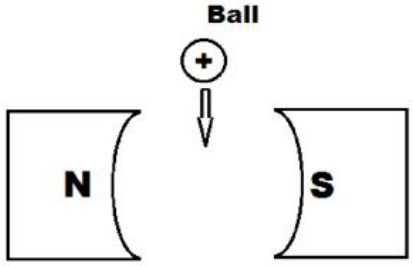
C. $\frac{q_1 q_2}{8\pi\varepsilon_o d^2}$

D. $\frac{q_1 q_2}{4\pi\varepsilon_o d^2}$



QUESTIONS

23. When a charged particle passes through a magnetic field, it is deflected. This deflection is dependent on the charge and the direction of the magnetic field. The diagram shows a positively charged ball falling through the jaws of a C-shaped magnet.



In which direction would the ball be deflected?

A. towards the north pole
B. towards the south pole
C. into the plane of paper
D. out of the plane of paper

24. A 15 kg mass is pulled along a horizontal frictionless surface with a component of force of 40 N along the east and a component of 30 N along north. What is the magnitude and direction (with respect to the east) of the acceleration of the mass?

A. $4.33\ m\,s^{-2}\ at\ an\ angle\ of\ 37^o$
B. $3.33\ m\,s^{-2}\ at\ an\ angle\ of\ 37^o$
C. $3.33\ m\,s^{-2}\ at\ an\ angle\ of\ 67^o$
D. $8.33\ m\,s^{-2}\ at\ an\ angle\ of\ 67^o$

25. When a tree dies it stops taking in carbon dioxide. The amount of carbon-14 decreases with time as it decays with a half-life of about 5700 years. What fraction of it would remain after 17100 years?

A. 7/8
B. 1/3
C. 1/8
D. 1/16

QUESTIONS

26. A dentist uses a spherical mirror to view the tooth of a patient. The required image is to be upright and five times the size of the tooth. Calculate the magnitude of the focal length of the mirror to be used if the tooth is to be viewed with the mirror 1.00 cm from the tooth.

A. $0.83\ cm$

B. $0.25\ cm$

C. $1.25\ cm$

D. $0.17\ cm$

27. A particle moves along a circular arc of length 5.00 cm. The angle subtended by the arc is 45^{o}. It takes 2.00 seconds to complete the arc. What is the frequency of the particle?

A. 0.125 Hz

B. 40.0 Hz

C. 2.50 Hz

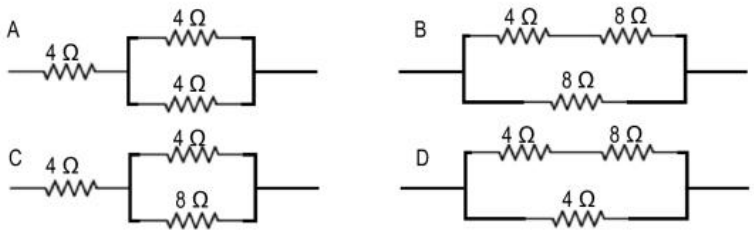
D. 0.0625 Hz

28. During construction of a certain building at Gaborone Central Business District, a crane raises a mass m through a vertical height h in time t at a constant velocity v. Which of the following gives the correct expression for the power P required to raise the mass?

A. $P = mg$
B. $P = mgh$
C. $P = \frac{mgh}{t}$
D. $P = \frac{mgv}{t}$

29. A student requires a 6 Ω resistor. The only resistors available in the laboratory are packs of 4 Ω and 8 Ω resistors. Which of the resistors combinations in the figure below would yield the required 6 Ω equivalent resistance?

QUESTIONS



30. Road accidents are a major concern to any nation. Momentum is a very crucial parameter when vehicles collide. When comparing the momentum of two moving vehicles, which of the following is correct?

A. The vehicle with the higher velocity will have less momentum, if the masses are equal.

B. The vehicle with a larger mass will have less momentum, if its velocity is greater.

C. The vehicle with a smaller mass will have less momentum, if the velocities are the same.

D. The vehicle with a smaller mass will have more momentum, if the velocities are the same.

15th International Junior Science Olympiad
Botswana
December 4, 2018

Multiple Choice Competition
Time : 3 hr
Points : 30

ANSWER SHEET

Name	MARKING GUIDE	Code	MCQ
Country	IJSO 2018	Signature	Sinicja

	Answers					Answers			
1	A	B	C	~~D~~	16	A	B	C	~~D~~
2	~~A~~	B	C	D	17	A	B	C	~~D~~
3	A	B	~~C~~	D	18	A	~~B~~	C	D
4	A	B	~~C~~	D	19	A	~~B~~	C	D
5	A	B	~~C~~	D	20	~~A~~	B	C	D
6	A	~~B~~	C	D	21	A	~~B~~	C	D
7	A	B	C	~~D~~	22	A	B	~~C~~	D
8	A	B	~~C~~	D	23	A	B	C	~~D~~
9	A	B	C	~~D~~	24	A	~~B~~	C	D
10	~~A~~	B	C	D	25	A	B	~~C~~	D
11	A	B	~~C~~	D	26	A	B	~~C~~	D
12	~~A~~	B	C	D	27	A	B	C	~~D~~
13	A	~~B~~	C	D	28	A	B	~~C~~	D
14	A	B	~~C~~	D	29	~~A~~	B	C	D
15	A	B	~~C~~	D	30	A	B	~~C~~	D

---------- DO NOT WRITE BELOW ----------

Correct answers		Wrong answers	
No answers		Total point	