Secondary 3 / Grade 9

Full Name: _____ **Country:** _____

School: _____ **Index Number:** _____

Instructions to Students:

1. Only scientific calculators are allowed during the contest for secondary school/Grade 7 and above students.
2. The duration of this contest is **1 hour**. You may not leave the contest venue within the first half an hour of the paper.
3. This examination paper contains **20** questions and comprises of **14** printed pages, inclusive of the cover page.
4. Each question has only 4 possible answers: **A, B, C** and **D.** You must shade your correct option on the Answer Entry Sheet provided.
5. The total marks for this paper is 70 points:
   Section A:
   Question 1 to 5: +2 points for correct answer, 0 points for no answer and −1 point for wrong answer.
   Section B:
   Question 6 to 10: +3 points for correct answer, 0 points for no answer or wrong answer.
   Section C:
   Question 11 to 20: +4 points for correct answer, 0 points for no answer or wrong answer.
6. You are not allowed to bring the question paper and answer script out of the contest venue.

Note:

1) You may assume that there is no air resistance throughout the contest, unless otherwise stated.

2) All temperatures are in degree Celsius, unless otherwise stated.

3) Room temperature is 25°C at 1 atmospheric pressure.

4) Gravitational Acceleration is taken to be 9.8 m/s^2.

Rough Working

Rough Working

Section A (Question 1 to 5: +2 points for correct answer, 0 points for no answer and −1 point for wrong answer.)

1. Singapore uses desalination as part of the 4 National taps where our water comes from. One of the ways which desalination can be done is through reverse osmosis.

   The diagram below shows how reverse osmosis works.
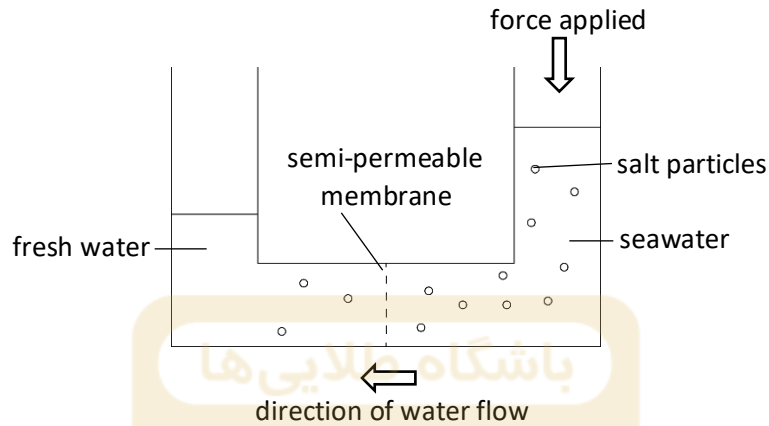
   If one day the reverse osmosis plant has a power failure, which of the following could be a result?

   A. Salt particles would go from right to left and the water level on the left would drop.
   B. Salt particles would go from right to left and the water level on the right would drop.
   C. Water molecules would go from left to right and the water level on the left would drop.
   D. Water molecules would go from left to right and the water level on the right would drop.

2. The relative atomic mass of oxygen is 16 and the relative molecular mass of ammonium sulfate is 132.

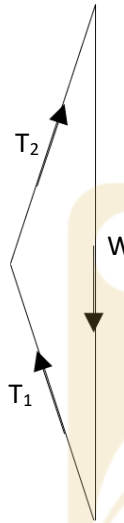   What is the percentage of oxygen in ammonium sulfate?

   A. 12.1%
   B. 24.2%
   C. 36.4%
   D. 48.5%

3. The diagram below shows a weight, W, being suspended by two strings, T_1 and T_2. The weight does not move.
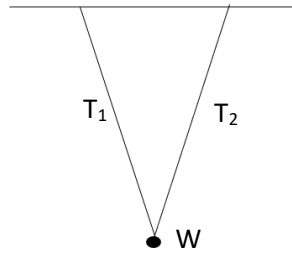
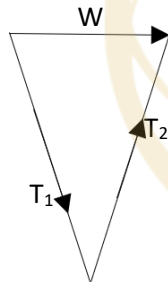Which of the following free-body diagrams shows all the forces present in the diagram?
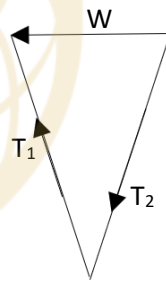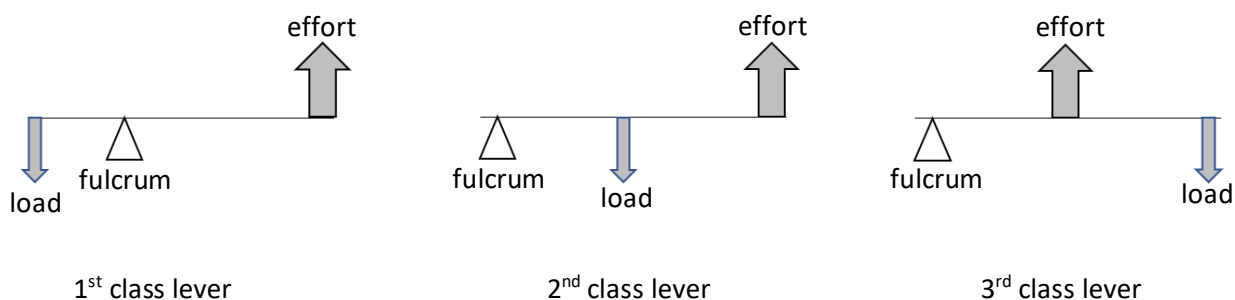
A.

B.

C.

D.

4. The following diagrams are examples of three different classes of levers.

effort | fulcrum | load

effort | fulcrum | load

effort | fulcrum | load

1st class lever

2nd class lever

3rd class lever

Which of the following is true about levers?

A. Brooms are typically used as 2nd class levers, instead of 1st class levers.
B. All 2nd class levers allow a larger force to act upon the load than is supplied by the effort.
C. For a 1st class lever to be used as a speed multiplier, the distance between the effort and fulcrum must be greater than the distance between the load and fulcrum.
D. For a 1st class lever to be used as a force multiplier, the distance between the load and fulcrum must be greater than the distance between the effort and fulcrum.

5. Excess aqueous sodium hydroxide was added to a test tube containing salt solution S. The solution was heated and a piece of damp red litmus paper was placed at the mouth of the test tube. The red litmus paper turned blue.

    After the reaction was complete, a piece of aluminium foil was added to the remaining solution. The aluminium foil dissolved in the warm solution and the gas given off from the bubbles turned damp red litmus paper blue.

    Which of the following could be a possible identity of salt solution S?

    A. aluminium chloride
    B. aluminium nitrate
    C. ammonium chloride
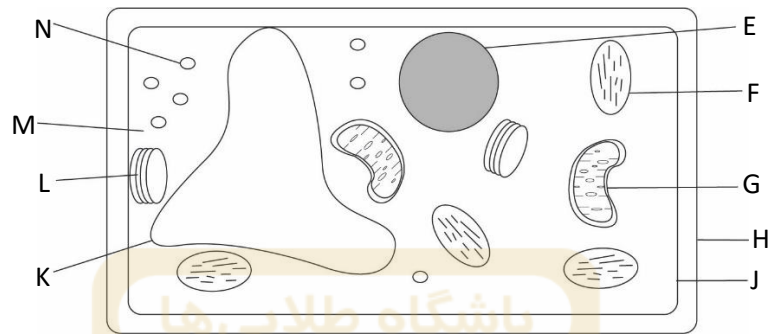   D. ammonium nitrate

Section B (Question 6 to 10: +3 points for correct answer, 0 points for no answer or wrong answer.)

Each question has 4 numbered options. Response is based on the following table:

A	B	C	D
1 is correct only	**1 and 3 correct only**	**2 and 4 correct only**	**1,2,3,4 are correct**

6. The diagram below shows a plant cell.

A cell taken from the Venus flytrap produces digestive enzymes, which are proteins. The enzymes are then released into the trap which digests insect that get trapped.

Which of the following are adaptations to its role as this type of cell?

1. Structure H is porous.
2. There are large numbers of N structures.
3. Structure F contains a green pigment that helps it to synthesis food.
4. There are large numbers of G structures.

7. A 'fit' person is characterised by someone who exercises on a regular basis. One of the ways how a person is deemed 'fit' is how quickly a quickened heartbeat rate returns to the resting heartbeat rate after a bout of vigorous activity. The faster it is for a quickened heartbeat rate returns to the resting heartbeat rate after a bout of vigorous activity, the more 'fit' the person is.

Which of the following statements is true for a 'fit' person?

1. 'Fit' people replace their oxygen reserves quickly.
2. 'Fit' people will always increase their heartbeat slower than not as 'fit' people.
3. 'Fit' people remove excessive lactic acid from their bodies quickly.
4. 'Fit' people always have enough oxygen in their blood for their muscles to respire aerobically.

8. The diagram shows a mercury barometer used to measure pressure of gases.
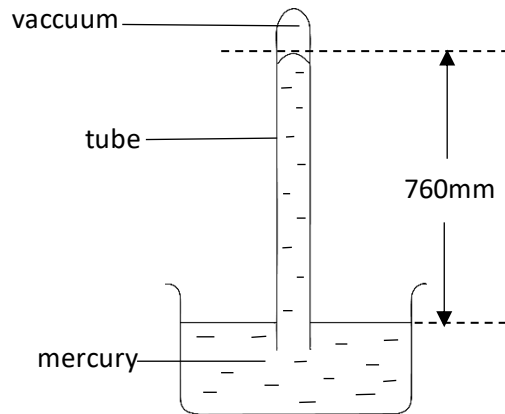
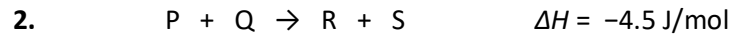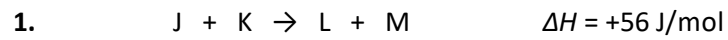The density of mercury is about 13600 kg m^{-3}.

Which of the following statements of the mercury barometer is true?

1. The atmospheric pressure in this diagram is about 101300 Pa.
2. If mercury was changed to a less dense liquid, the resultant liquid column will be more than 760 mm.
3. If the tube was changed to have a larger internal diameter, the length of the mercury column would still be 760 mm.
4. If the tube was tilted slightly but the mouth of the tube was still immersed in the mercury, the mercury column would still be 760 mm.

9. Hot-air balloons are a way of transport for tourists to enjoy the scenery of the countryside.

Which of the following statements are true of how hot-air balloons work?

1. The mass of air inside the balloon is relatively smaller than the outside, and therefore lighter.
2. Fire used to warm the air inside the hot-air balloon causes the volume of air to increase.
3. The air particles inside the hot-air balloon are relatively smaller than the outside, and therefore lighter.
4. As the air inside the hot-air balloon loses heat to the surroundings, the air becomes denser and the hot-air balloon will descend.

10. Study the details of the following four equations. Which of the following reactions could be considered to be used as a substitute for an icepack?

1. $J + K \rightarrow L + M$ $\Delta H = +56$ J/mol

2. $P + Q \rightarrow R + S$ $\Delta H = -4.5$ J/mol

3. $NT_4 \rightarrow N + 4T$

4. $2U + 3W \rightarrow U_2W_3$

Section C: (Question 11 to 20: +4 points for correct answer, 0 points for no answer or wrong answer.)

11. Cellulose is a polysaccharide and is made from many glucose monomers. The structural difference between cellulose and starch is how the glucose monomers are linked together. Cellulose is the main constituent of a plant cell wall.

    Which of the following statements is true of cellulose?

    A. Cellulose will not turn iodine blue-black.
    B. Human salivary amylase is able to break down cellulose.
    C. Human beings are able to digest cellulose in the alimentary canal.
    D. When cellulose is digested, the product is able to yield a violet with Biuret's solution.

12. Amyotrophic lateral sclerosis, or ALS, is a specific disease that causes the death of neurons controlling muscles, including the ones in the digestive system.

    Which of the following is a consequence of this disease affecting the digestive system?

    A. constipation
    B. inability to breathe
    C. inability to produce insulin
    D. inability to produce digestive enzymes

13. Jane wanted to conduct an experiment to investigate the rate of transpiration by plant P. She removed four similar leaves from plant P and coated one or both surfaces with grease to prevent transpiration. The table below shows her results.

	leaf 1	leaf 2	leaf 3	leaf 4
surface coated with grease	none	upper side only	lower side only	both sides
variable V	40	36	4	2

    Afterwards, she did a second experiment and found out that plant P had more stomata on the lower side of the leaves.

    What was the variable, V, she measured in the first experiment?

    A. the volume of water absorbed
    B. the volume of carbon dioxide absorbed
    C. the decrease in mass due to water loss
    D. the decrease in mass due to oxygen loss

14. The gravitational field strength from any given body, g, can determined by the following formula:

$$g = G\frac{m}{r^2}$$

where G is the gravitational constant, m is the mass of the body and r is the distance from the centre of the Earth to the centre of the object.

Which of the following statements is true about the gravitational field strength?

A. A larger mass of the body will result in a larger gravitational field strength.
B. A smaller mass of the body will result in a larger gravitational field strength.
C. Gravitational field strength decreases when both the masses are closer to each other.
D. It is more difficult to escape the gravitational field strength of a body when the object is further away from the body.

15. The graph below shows the displacement-time graph for an object, which has insignificant mass and volume, starting from the origin, O.
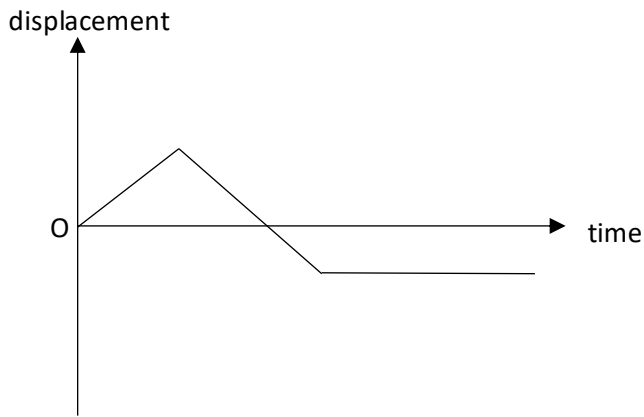
Which of the following graphs shows the speed-time graph for the same object moving along the same path?
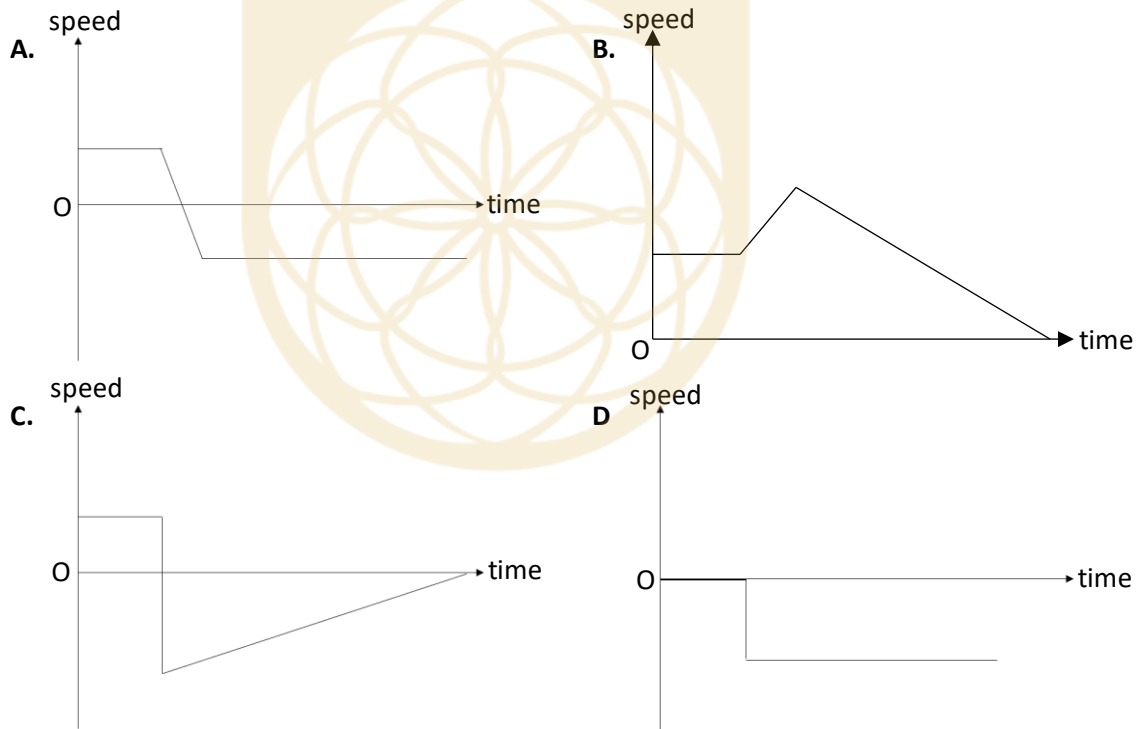
16. A liquid substance which had a specific heat capacity, *c,* was placed into a closed and ideal system. The temperature of the liquid at the start of the experiment was T_1 °C. A fixed amount of heat energy, *Q* J, was applied to the liquid substance. The final temperature was recorded to be T_2 °C. Assume that all the heat energy was used to raise the temperature of the liquid to T_2 from T_1, and the mass of the liquid present in the system was *m* kg.

What was the specific heat capacity of the liquid, *c,* in J kg⁻¹ K⁻¹?

A. $\dfrac{mT_2}{Q}$

B. $\dfrac{m(T_2-T_1)}{Q}$

C. $\dfrac{Q}{mT_2}$

D. $\dfrac{Q}{m(T_2-T_1)}$

17. The table below shows of properties of three substances, J, K and L.

	ability to conduct electricity in solid state	ability to conduct electricity in molten state	melting point
J	yes	yes	not fixed
K	no	yes	high
L	no	no	low

Which of the following could be the identities of J, K and L?

	J	K	L
A.	iron	lithium chloride	iodine
B.	bronze	lithium chloride	iodine
C.	lithium chloride	iodine	iron
D.	iodine	bronze	lithium chloride

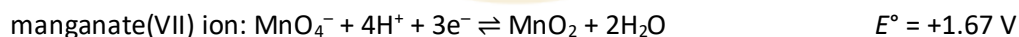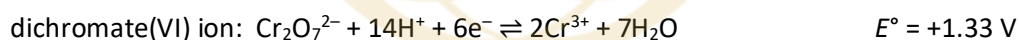18. The diagram below shows an electrolysis set-up for molten lead(II) bromide, $PbBr_2$.
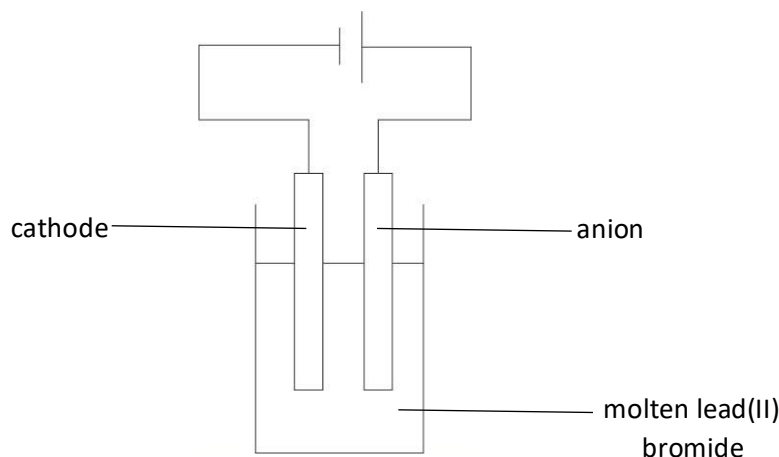
Which of the following statements is not true about the set-up?

A. Pb^{2+} ions gain electrons at the cathode and become Pb metal.
B. Br^- ions lose electrons at the anode and form Br_2.
C. Aqueous lead bromide works better than the molten lead bromide in this experiment.
D. The electrodes must be able to withstand high heat, otherwise they would need to be constantly replaced.

19. Potassium dichromate(VI) was once a common oxidising agent used in school laboratories during chemistry experiments until it was deemed to be carcinogenic and its usage was immediately halted.

The following equations are the standard electrode potential values, $E°$ at 25°C

dichromate(VI) ion: $Cr_2O_7{}^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$ $E° = +1.33$ V

manganate(VII) ion: $MnO_4{}^- + 4H^+ + 3e^- \rightleftharpoons MnO_2 + 2H_2O$ $E° = +1.67$ V

Which of the following statements can be inferred from the information above?

A. Potassium dichromate(VI) can oxidise potassium manganate(VII).
B. A positive $E°$ value means the reaction tends to proceed to the right.
C. The oxidation number for chromium in potassium dichromate(VI) is −6.
D. Potassium dichromate(VI) will not work in a neutral aqueous environment.

20. The following table shows the results of three experiments carried out at the same temperature to investigate the rate of the reaction between liquid compounds **V** and **W**.

	Experiment 1	Experiment 2	Experiment 3
Initial concentration of **V**/mol dm^{-3}	0.50	0.25	0.25
Initial concentration of **W**/mol dm^{-3}	0.36	0.36	0.72
Initial rate/mol dm^{-3}s^{-1}	2.8×10^{-3}	1.4×10^{-3}	1.4×10^{-3}

Which of the following statements is true for this experiment?

A. The rate of reaction order with respect to **V** is 2.
B. Increasing the pressure will have significant impact on the reaction.
C. From the experimental data, it can be deduced that the rate equation is $rate = k[V]^2[W]$.
D. Diluting **V** will reduce the speed of reaction in this experiment.