13th INTERNATIONAL KANGAROO SCIENCE CONTEST 2020

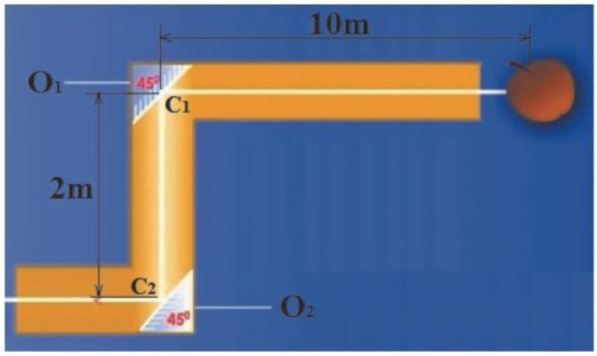
Junior Level (Class 9 & 10)

Time Allowed: 90 minutes

ALL QUESTIONS WORTH 4 POINTS

Atomic masses: *Na-23; Ca-40; O-16; Cl-35.5; S-32; N-14*

1. The plane mirrors O_1 and O_2 are placed at an angle of 45° relative to the vertical axis of the periscope, so that their centers are at a distance of 2m. Suppose that a point object, is at a distance of 10m from the center of the mirror O_1. At what distance from the center of the mirror O_2 is the image of this object formed?



A) 2m **B)** 10m **C)** 8m
D) 24m **E)** 12m

2. A quantity of 30g of sugar is dissolved in water to give 250g of solution. Then the solution is heated to boil. The mass of water that has to evaporate in order to double the concentration of sugar is:

A) 100g **B)** 150g **C)** 50g
D) 200g **E)** 125g

3. In a gas mixture, 20% of the total mass is O_2, the rest of the gas being N_2. Given the molar masses of the gases: $\mu_{O_2} = 32\ g\ /\ mol$ and $\mu_{N_2} = 28\ g\ /\ mol$, the molar mass of the mixture thus formed is:

A) 29.5 $g\ /\ mol$ **B)** 28.7 $g\ /\ mol$ **C)** 30 $g\ /\ mol$
D) 31 $g\ /\ mol$ **E)** 29 $g\ /\ mol$

4. In a galvanic cell, the potential of the electrode where the oxidation process takes place has:

A) negative sign (anode)
B) positive sign (cathode)
C) a sign which depends on the concentration of the solution
D) no sign
E) the sign of the terminal to which it is connected

5. A beam of light passes from air into a liquid at an angle of incidence $i = 60°$. The refractive index of the liquid is $n = \sqrt{3}$. The angle of refraction is:

A) 60° **B)** 30° **C)** 90°
D) 45° **E)** 0°

6. Which of the following is an oxidation-reduction (redox) process?

A) $MgO + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2O$
B) $Mg + CuSO_4 \rightarrow MgSO_4 + Cu$
C) $AgNO_3 + HI \rightarrow AgI + HNO_3$
D) $CuSO_4 + NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$
E) $AlCl_3 + 4KOH \rightarrow K[Al(OH)_3] + 3KCl$

7. Which of the following statements is correct?

A) In the case of the solenoid, the magnetic field has open field lines.
B) On the axis of a thin solenoid, the magnetic field is uniform.
C) The induction of a magnetic field produced by an electric current is inversely proportional to the current intensity.
D) The induction of a magnetic field produced by an electric current is the same at any distance from the conductor.
E) For linear conductors, the magnetic field lines are coplanar with the conductor.

8. A heterogeneous mixture contains iron powder, copper filings and kitchen salt. To separate the compounds of the mixture we will proceed as follows:

A) use a magnet to separate the iron powder, add water to dissolve the salt, decant the liquid mixture to separate the copper filings, then boil the remaining solution to crystallize the salt
B) add water to dissolve the salt, decant the liquid, use a magnet to crystallize the salt
C) use a magnet and then sift the mixture of salt and copper powder
D) sieve the solid mixture
E) use a magnet, add water to dissolve the salt and boil the liquid mixture to condense the released vapours

9. By heating a cylinder, made of an isotropic material, its diameter increases twice. Then the cylinder's height:

A) decreases twice **B)** decreases four times
C) increases twice **D)** increases four times
E) remains unchanged

10. Lime chloride is a compound with disinfectant properties which has the chemical formula: $CaOCl_2$. This substance contains as a percentage by mass:

A) 12.6% *Ca* **B)** 31.5% *O* **C)** 55.9% *Cl*
D) 30% *O* **E)** 16.2% *O*

11. A number of n identical batteries, having an electromotive force *E* and an internal resistance r, are connected either all in series or all in parallel to an external resistance *R*. Can the current through this resistance be the same, in both cases?

A) It is the same, always
B) It can never be the same
C) It will be the same only if $R << r$
D) It will be the same only if $r << R$
E) It will be the same only if $r = R$

12. The differences between the physical and chemical properties of the compounds of the chlorine isotopes with the hydrogen atom are determined by:

A) color **B)** mass **C)** chemical bond
D) electric properties **E)** chemical formula

13. A beam of white light falls at an angle of incidence *i* on a glass blade with parallel-plane faces. At the exit through the blade we will see:

A) A beam of white light, parallel to the incident one
B) A beam of white light propagating at an angle $r < i$
C) A beam of white light propagating at an angle $r > i$
D) Beams of different colours of the spectrum, which propagate parallel to the incident one
E) Beams of different colours of the spectrum, which propagate in different directions

14. Which of the following are the stoichiometric coefficients of the substances in the chemical reaction equation $xHI + yHIO_3 \rightarrow zI_2 + tH_2O$?

A) $x = 3; y = 1; z = 3; t = 3$ **B)** $x = 5; y = 1; z = 3; t = 3$
C) $x = 1; y = 3; z = 2; t = 2$ **D)** $x = 3; y = 3; z = 1; t = 5$
E) $x = 1; y = 5; z = 3; t = 3$

15. If in a series of n identical capacitors, two of them break, then the equivalent capacity:

A) Increases $\frac{n}{n-2}$ times
B) Increases n times
C) Decreases $(n-2)$ times
D) Increases $(n-2)$ times
E) Increases $\frac{n-2}{n}$ times

16. The atom of element *E* needs three electrons to achieve an octet configuration on the third shell. The number of protons of element *E* is:

A) 3
B) 10
C) 15
D) 25
E) 30

17. Consider a perfectly elastic collision between two bodies of equal masses which move in the same direction. Which of the following statements is true?

A) One body stops, the other moves at a speed equal to the sum of the initial speeds of the bodies
B) One body stops, the other moves at a speed equal to the difference of the initial speeds of the bodies
C) The bodies gain equal velocities of opposite directions
D) The bodies interchange their speeds
E) The bodies stop

18. The particles contained in the nucleus of the radioactive oxygen isotope $^{18}_{8}O$ are:

A) 10 protons
B) 18 protons
C) 18 neutrons
D) 8 protons and 10 neutrons
E) 10 protons and 8 neutrons

19. If a convergent glass lens (n_g = 1.5) of focal length f (in air) is introduced into water (n_w = 4/3) then:

A) it will behave like a divergent lens
B) its focal distance will remain the same
C) its focal distance will increase four times
D) its convergence power will increase four times
E) it will only form real images that are larger than the object

20. Some chemical elements of a group in the periodic system form diatomic compounds which are in three aggregation states: gaseous, liquid and solid. Which of the following sequences contains only such chemical elements?

A) *Li, Na, K* **B)** *Al, Ga, Tl* **C)** *C, Si, Ge*
D) *O, S, Se* **E)** *Cl, Br, I*

21. If a real object is located in front of the optical center of a concave mirror, its image will be:

A) Real, right-side up and larger than the object
B) Virtual, right-side up and larger than the object
C) Real, upside down and smaller than the object
D) Virtual, upside down and smaller than the object
E) Virtual, right-side up and smaller than the object

22. Choose the string containing only nonpolar substances:

A) CO_2, SiH_4, N_2O_3 **B)** H_2S, S_8, Na_2C_2 **C)** CH_4, HCl, H_2
D) H_2, H_2O, O_2 **E)** CCl_4, Cl_2, N_2

23. Two identical circular coils are placed coaxially, at a distance d from each other. If through the two coils, the current flows in the same direction, then:

A) they will attract each other
B) they will begin to rotate in the same direction
C) they will begin to rotate in opposite directions
D) they will repel each other
E) they will be positioned into perpendicular planes

24. If chlorine gas is bubbled into the potassium iodide solution, we will observe:

A) the colouring of the solution into yellow-green due to gas bubbling
B) the cooling of the solution due to the dissolution of the gas
C) the release of purple iodine vapours
D) the crystallization of potassium chloride
E) the colouring of the solution into yellow-brown due to the dissolution of the formed iodine in the excess of potassium iodide

25. Determine which of the following statements about mechanical work is false:

A) It is a scalar quantity
B) Its graphical representation, in coordinates (F, d), represents the area of a surface
C) It is null when the force is perpendicular to the movement direction
D) It is minimal when the force has an opposite direction to the movement
E) It is always positive

26. The sour taste of a lemon is due to the citric acid. The lemon juice contains 6.5% citric acid. The concentration of citric acid in a solution consisting of $20g$ of lemon juice and $20g$ of water is:

A) 3.25% **B)** 6.5% **C)** 10%
D) 15.25% **E)** 20%

27. Given that the latent heat of melting ice is 335 kJ/kg and the specific heat of water is 4180 $J/kg \cdot K$, determine the minimum amount of water at $20^{\circ}C$ needed to melt $10g$ of ice at $0^{\circ}C$:

A) $4kg$ **B)** $40kg$ **C)** $4g$
D) $400g$ **E)** $40g$

28. What volume of O_2 is obtained in the process of photosynthesis:

$$nCO_2 + nH_2O \rightarrow C_nH_{2n}O_n + nO_2$$

from $3m^3$ of CO_2?

A) $67.2m^3$ **B)** $22.4m^3$ **C)** $3m^3$
D) $3L$ **E)** $6m^3$

29. A voltage source has a short-circuit current equal to $10A$ and an idle voltage of $15V$. In these conditions, the internal resistance of the source:

A) cannot be calculated with the given data
B) is null
C) tends to ∞
D) is 150 Ω
E) is 1.5 Ω

30. **Chloroform is used as an anaesthetic substance, which can be obtained by photochemical trichlorination of methane. The molecular formula of chloroform is:**

A) CH_3Cl **B)** CH_2Cl_2 **C)** CH_2Cl_3
D) CCl_3 **E)** $CHCl_3$