Use the information below to answer the question:

$\sin 30^\circ = \frac{1}{2}$ $\cos 30^\circ = \frac{\sqrt{3}}{2}$

$\sin 45^\circ = \frac{\sqrt{2}}{2}$ $\cos 45^\circ = \frac{\sqrt{2}}{2}$

$\sin 60^\circ = \frac{\sqrt{3}}{2}$ $\cos 60^\circ = \frac{1}{2}$

$\sin 37^\circ = \frac{3}{5}$ $\cos 37^\circ = \frac{4}{5}$

$\sin 53^\circ = \frac{4}{5}$ $\cos 53^\circ = \frac{3}{5}$

$\pi \approx \frac{22}{7}$ $\sqrt{2} = 1.414$

$\sqrt{3} = 1.732$ $\sqrt{5} = 2.236$

$\sqrt{7} = 2.646$ $\sqrt{10} = 3.162$

Acceleration due to gravity = 10 m/s^2.

Atmospheric pressure = 10^5 Pa.

The speed of sound in the air at 0 ℃ = 331 m/s.

The Coulomb constant (k) in the air or vacuum = 9×10^9 $N \cdot m^2/C^2$.

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Instructions :

1. Each question carries a different score, as indicated at the end of the question.
2. Students must select only the one best answer for each question.

1. Students found information about 3 types of hormones with different properties as follows:

Hormone A causes wheat seeds to stay dormant before harvesting.

Hormone B stimulates the ripening of sapodilla fruits.

Hormone C helps to elongate clusters and enlarge the size of grapes

Based on the information above, which of the statements correctly describes the influence of hormones A, B, and C? (1.25 marks)

1. Hormone B inhibits the synthesis of proteins stored in plant seeds.

2. Under drought conditions, plants produce hormone B to stimulate the closure of stomata.

3. Hormone C stimulates the production of enzymes to digest starch stored in seeds into sugar.

4. Hormone A and C act antagonistically, with hormone A being produced at the shoot tip and hormone C being produced at the root and transported to the target tissue.

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2. A patient suffers a traumatic brain injury, leading to damage in the hypothalamus. Several days later, the patient develops severe hyperthermia, despite aggressive cooling measures, and also exhibits profound polyuria (excessive urination) even with normal fluid intake. Explain the most likely homeostatic dysregulations at play, connecting the hypothalamic damage to the observed symptoms. (1.25 marks)

1. The patient is experiencing a stress-induced increase in adrenal hormones, which cause both a rise in body temperature and an increase in glomerular filtration rate in the kidneys.

2. The injury has triggered a systemic inflammatory response, causing widespread vasoconstriction and fluid retention, which explains both the hyperthermia and polyuria.

3. The hypothalamic damage has likely impaired the anterior pituitary's ability to release growth hormone, leading to metabolic derangements that cause heat production and increased kidney filtration.

4. Damage to the hypothalamic osmoreceptors and thermoregulatory centers disrupts ADH secretion, leading to diabetes insipidus and polyuria, and impairs the body's ability to dissipate heat, resulting in hyperthermia.

3. Courtship behavior of male mallard drake by beak shaking, shaking and stretching, tail shaking, chirping, head lifting, tail lifting, looking for female ducks, head lowering for swimming, head lifting, and lowering to show off the back of the head. What are the causes of these behaviors? (1.25 marks)

A. Fixed action pattern (FAP)
B. Genetic inheritance
C. Animal instinct
D. Development of behavior over time

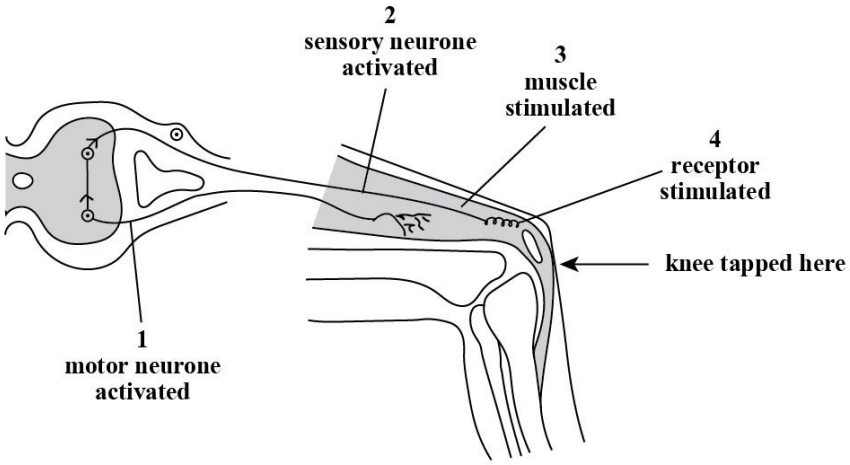
1. A, B
2. A, B, C
3. B, C, D
4. A, B, C, D

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4. Suppose the plant *Brassica rapa* has 2 alleles for dark green leaf color that results in all dark green leaves. The second plant, *Brassica rapa*, has 1 allele for dark green leaf color and 1 allele for yellowish-green leaf color but still has all dark green leaves. Based on this information, which term best describes the relationship between these 2 alleles, in terms of the resulting phenotype, assuming that the leaf color character is controlled by a single gene? (1.25 marks)

1. The alleles for the gene coding for leaf color are sex-linked.
2. The alleles for the gene coding for leaf color are codominant.
3. The allele for dark green leaf color is dominant to that of yellow-green leaf color.
4. The allele for yellow-green leaf color is dominant to that of dark green leaf color.

5. The diagram shows a simple reflex arc.



What is the correct order of events after the knee is tapped? (1.25 marks)

1. 1 ⟶ 2 ⟶ 3 ⟶ 4
2. 1 ⟶ 4 ⟶ 2 ⟶ 3
3. 4 ⟶ 2 ⟶ 1 ⟶ 3
4. 4 ⟶ 3 ⟶ 2 ⟶ 1

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6. In a chemistry Olympiad-level laboratory, a student accidentally dropped a test tube containing gas X, causing its tip to break off. As a result, gas X gradually diffused into the atmosphere through a small hole in the rubber stopper. To compare the rate of diffusion of gas X with oxygen gas (O_2), the student conducted an experiment using the same size hole in the rubber stopper under the same conditions. The results were as follow:

Gas X took 45 seconds to completely diffuse out of the test tube.

O_2 took only 25 seconds to completely diffuse out of the test tube.

Relative atomic mass : Kr = 84, Ar = 40, S = 32 , O = 16 , C = 12

Based on the information provided, what is gas X? (1.25 marks)

1. Krypton (Kr)
2. Argon (Ar)
3. Sulfur dioxide (SO_2)
4. Carbon dioxide (CO_2)

7. Part of the development of space technology involves launching various types of satellites into Earth's orbit. Information about the purposes of various types of satellites is shown in the table.

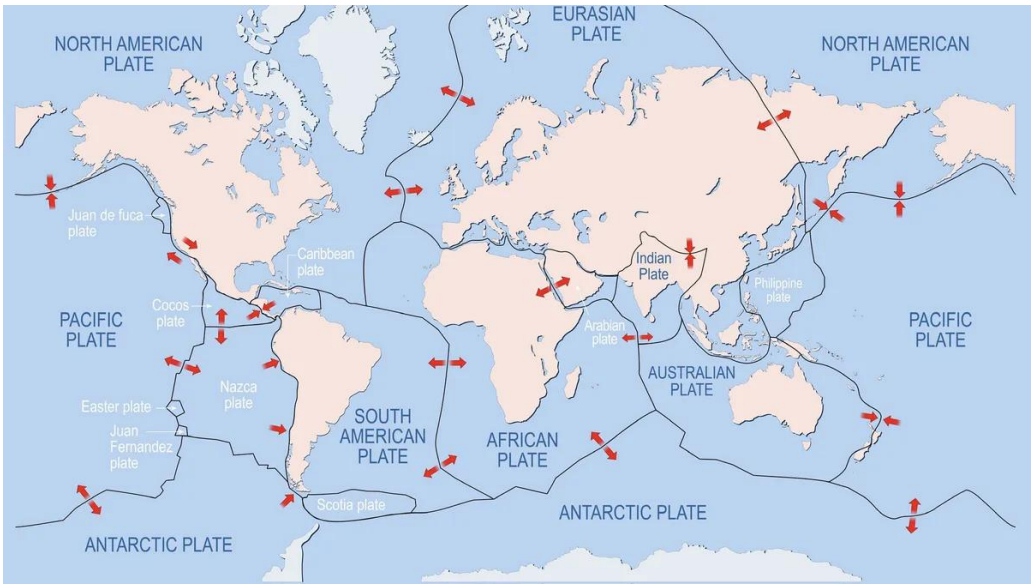
Types of satellites	Purpose of use
Communication satellite	Broadcasting of telephone, television, and internet signals
GPS satellite	Determining precise location and altitude on Earth
Meteorological satellites	Collecting data about Earth's atmosphere and surface to understand weather patterns and improving forecasting
Earth observation satellites	Detecting changes in Earth's vegetation, atmospheric trace gases, sea conditions, ocean color, and ice fields

Based on the information provided, if farmers want to plan their cultivation to suit the weather conditions and monitor the growth of crops in their area, which type of satellite data should they primarily use? (1.25 marks)

1. Communication satellite and GPS satellite
2. GPS satellite and meteorological satellites
3. Meteorological satellites and Earth observation satellites
4. It is necessary to use all satellite data

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8. Japan is located at the intersection of several tectonic plates, as shown in the figure. As a result, Japan has geological features and geological disasters resulting from plate movement.



Based on the information above, which type of plate movement results in the formation of Japan and why? (1.25 marks)

1. The oceanic plate moves toward the continental plate, forming the Japan Trench.
2. The continental plate moves towards another continental plate, resulting in a long volcanic belt across Japan.
3. The oceanic plates slide past each other along transform boundaries due to many fault zones running through Japan.
4. The oceanic plates move towards one another, forming Japan’s island arc morphology.

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9. In the ASMOPSS laboratory, students conducted an experiment involving the reaction:

$$2NO\ (g) + O_2\ (g) \longrightarrow 2NO_2\ (g)$$

They measured the initial rate of the reaction at constant temperature and obtained the following data:

Experiment	[NO] ($mol \cdot dm^{-3}$)	[O_2] ($mol \cdot dm^{-3}$)	Initial rate ($mol \cdot dm^{-3} \cdot s^{-1}$)
1	0.10	0.10	1.20×10^{-3}
2	0.20	0.10	4.80×10^{-3}
3	0.20	0.20	9.60×10^{-3}
4	0.30	0.10	1.08×10^{-2}

Which of the following is the correct value of the rate constant (k)? (1.25 marks)

1. $0.012\ mol^{-2} \cdot dm^{6} \cdot s^{-1}$
2. $0.12\ mol^{-2} \cdot dm^{6} \cdot s^{-1}$
3. $1.20\ mol^{-2} \cdot dm^{6} \cdot s^{-1}$
4. $12.0\ mol^{-2} \cdot dm^{6} \cdot s^{-1}$

10. Astronomers studying stars in the Milky Way Galaxy have obtained the following data:

Star	Mass (M_{sun})	Color	Temperature (K)
A	0.5	red	3,000
B	1.0	yellow	5,800
C	15.0	blueish white	20,000

Given that all stars are in the main sequence, which of the following can be most correctly concluded? (1.25 marks)

1. Stars A have an M-type spectrum and have a shorter lifespan than stars C.
2. Stars B have a K-type spectrum and have a longer lifespan than stars C.
3. Star C has a B-type spectrum and has the shortest lifespan.
4. Stars A and B have spectral type K and have a longer lifespan than stars C.

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11. When the universe was approximately 300,000 years old after the Big Bang, it was still hot and extremely dense. Protons, electrons, and neutrons remained separated, unable to combine into stable atoms. As a result, light could not travel freely and was constantly scattered. The changes in various particles in the universe are shown in the table below.

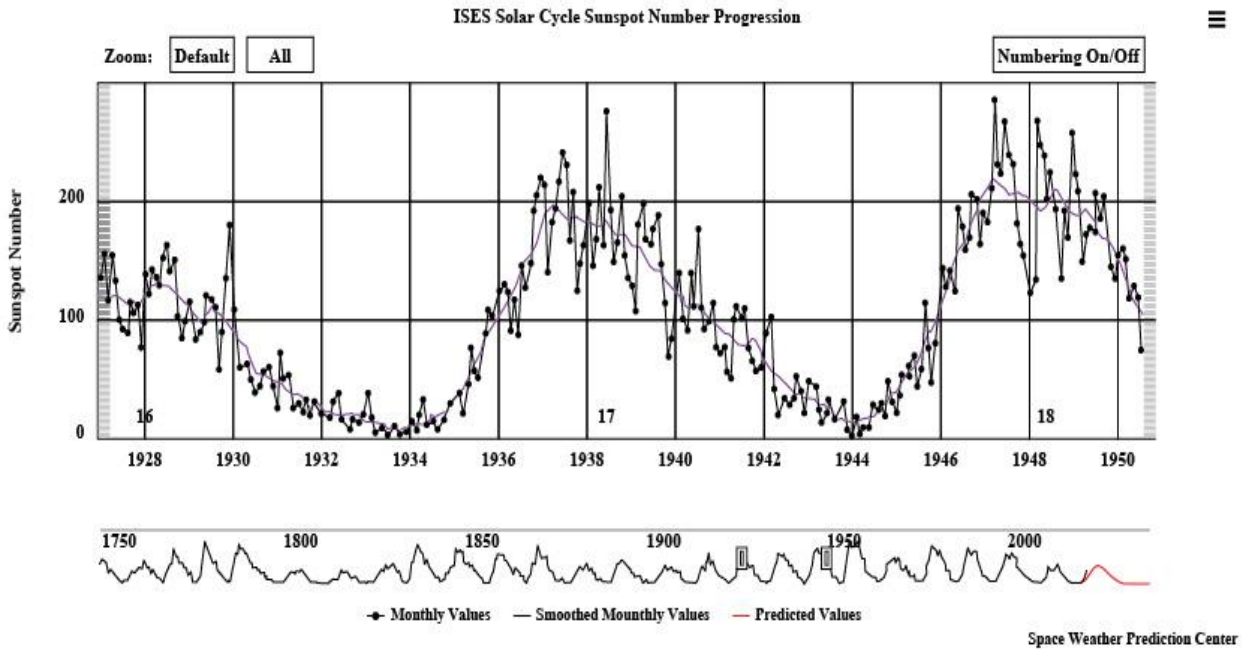
Time after the Big Bang	10^{-43} – 10^{-32} second	10^{-32} – 10^{-6} second	10^{-6} second - 3 minutes	3 minute – 300,000 year	300,000 year – 1,000 million years	1,000 million years - 13,800 million years
Object in the universe	quark antiquark electron positron neutrino antineutrino	quark antiquark electron positron neutrino antineutrino photon	electron positron neutrino antineutrino photon neutron proton	electron neutrino photon neutron proton Helium nucleus	neutrino photon Hydrogen atom Helium atom	neutrino photon galaxy

What events occurred after that event and are consistent with the evolution of the universe according to the Big Bang theory? (1.25 marks)

1. Neutrino combines with antineutrino to form photons.
2. The universe began to enter the Dark Era before the first stars were formed.
3. Electrons combine with protons to form hydrogen nuclei.
4. Electrons combine with atomic nuclei, making the universe more transparent and allowing light to travel freely.

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12. Astronomers observed sunspots, which are regions on the Sun with lower temperature than the surrounding areas of the photosphere and have stronger magnetic fields than other areas. The figure below shows a cycle of sunspots.

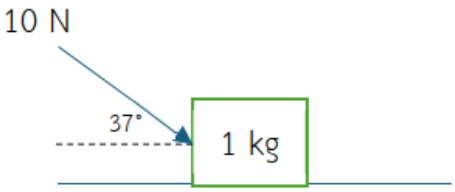


From the information above, which conclusion is the most accurate? (1.25 marks)

1. In 1934, the solar wind was at its most intense level in a decade.
2. The period with the number of sunspots decreased to its lowest point lasted about 20 years.
3. In 1948, solar wind, solar storms, and coronal mass ejections occurred less frequently than in 1944.
4. In 1938, a high number of sunspots caused aurora to appear more frequently in the polar regions.

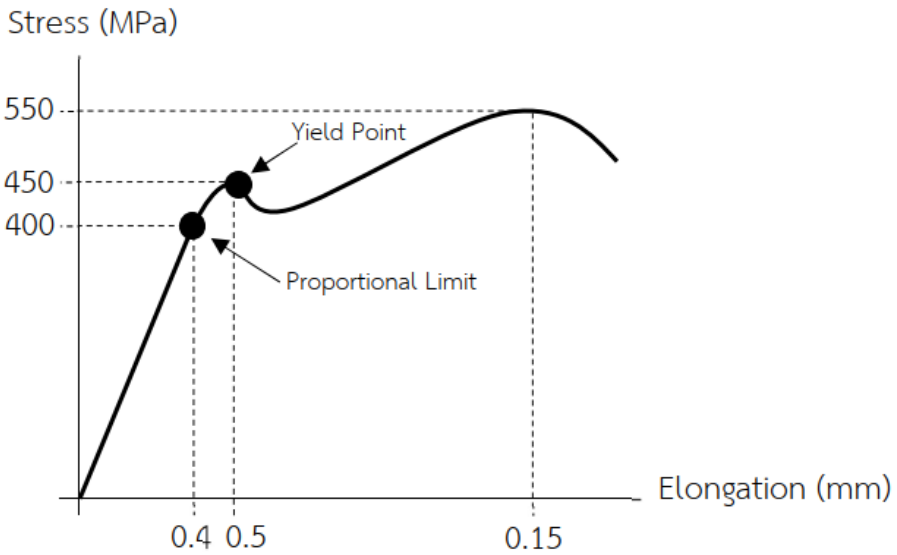
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13. A force of 10 N is applied at an angle of 37° above the horizontal to a mass of 1 kg placed on a rough horizontal surface, as shown in the figure. The mass then starts moving. What is the coefficient of static friction between the object and the surface? (1.25 marks)



1. 0.3
2. 0.5
3. 0.75
4. 0.8

14. An experiment studied the relationship between stress and strain of an 8-cm long material, yielding the results as shown in the figure.



According to the result, what is Young's modulus of the material? (1.25 marks)

1. 80 GPa
2. 500 GPa
3. 900 GPa
4. 1,000 Gpa

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15. An object is dropped from a height *h* above the ground. How long after release will the object's kinetic energy be equal to four times its potential energy? Assume that the potential energy at ground level is zero. (2.5 marks)

1. $\frac{\sqrt{h}}{2}$ s
2. $\frac{\sqrt{h}}{5}$ s
3. $\frac{\sqrt{2h}}{5}$ s
4. $\frac{\sqrt{5h}}{2}$ s

16. A particle with a mass 0.4 g undergoes simple harmonic motion with its position (in meters) as a function of time (in seconds) given by x = 0.98 sin (100πt).
Determine which of the following statements is true at time t = 1/50 seconds. (2.5 marks)

1. The velocity, acceleration, and position of the particle all have the same direction.
2. The velocity of the particle is opposite in direction to both the acceleration and the position.
3. The velocity of the particle is opposite in direction to the acceleration but in the same direction as the position.
4. The velocity of the particle is in the same direction as the acceleration but opposite to the position.

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17. A patient who has recently undergone surgery to remove tumors from his thyroid gland suddenly begins to tremble violently from head to toe because his nerves have become too exciting. What is the reason behind this? (2.5 marks)

1. Too much thyroid tissue was removed, and without oxytocin, blood calcium levels fell too low.
2. The parathyroid glands were removed, and without parathyroid hormone (PTH), blood calcium levels rose too high.
3. The parathyroid glands were removed, and without parathyroid hormone (PTH), blood calcium levels fell too low.
4. Too much thyroid tissue was removed, and without calcitonin, blood calcium levels fell too low.

18. The calendar shows the menstrual cycle of a woman in September

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	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				

Keys:

15 = Ovulation

2-6, 29-30 = Menstruation

Why could fertilization not take place if sperms are released into the vagina on 8th September? (2.5 marks)

1. Sperms are washed out of the female uterus by the menstrual flow.
2. Sperms can survive in the female reproductive system only for 2 or 3 days.
3. Sperms must be released after ovulation for fertilization to take place.
4. The uterus lining is washed out of the female body during menstruation.

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19. A professional athlete is participating in an Ironman triathlon, a grueling event that involves swimming, cycling, and running over extreme distances. The race is taking place in a tropical climate where temperatures are consistently high and humidity is intense. Throughout the competition, the athlete's muscles generate a massive amount of heat, consume significant amounts of glucose, and require a constant supply of oxygen. Simultaneously, the athlete experiences profuse sweating, leading to a substantial loss of body fluids and electrolytes. Despite regular intake of water and energy drinks, the athlete's body is under immense stress as it strives to maintain a stable internal environment. Considering the body's homeostatic mechanisms in this extreme scenario, which of the following statements is INCORRECT? (2.5 marks)

1. The excessive water loss through sweating will lead to increased thirst and stimulate the kidneys to excrete more dilute urine, aiming to prevent dehydration.

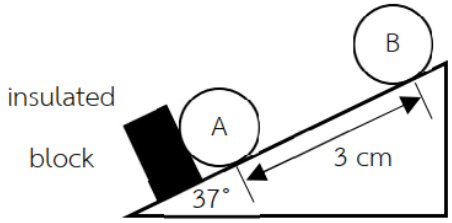
2. To prevent overheating, the body will primarily increase blood flow to the skin through vasodilation, allowing more heat to radiate and conduct away from the body's core.

3. The rapid depletion of glucose by working muscles will initially trigger the pancreas to release glucagon, stimulating the liver to convert stored glycogen into glucose to maintain blood sugar levels.

4. If the athlete's core body temperature continues to rise uncontrollably, vital enzyme functions will be disrupted, leading to potential organ damage and a severe condition known as heat stroke.

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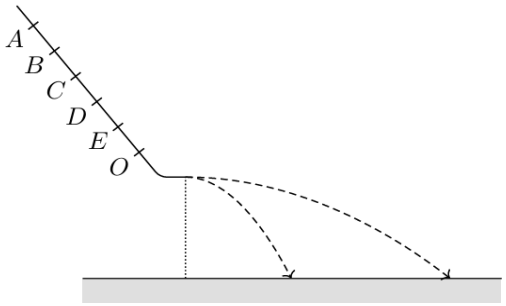
20. Two small spheres, each with a charge of +0.5 μC and a mass of 500 g, are placed on a frictionless, inclined plane angled at 37°, with an insulated block as shown in figure.



What is the magnitude of the reaction force between A and an insulated block? (2.5 marks)

1. 4.5 N
2. 5.0 N
3. 5.5 N
4. 6.0 N

21. The startup delivery company “Tundi” is testing a new parcel delivery system using a simple, self-designed frictionless ramp, as shown in the figure, because there is no budget for an electric rail. The end of the slope is horizontal. Parcels are released by simply placing them on the rail and letting them slide down on their own without any additional force.



From the first experiment, when the package was released from point O, it slid down the ramp and landed on the horizontal ground at a distance of 10 centimeters from the end of the ramp.

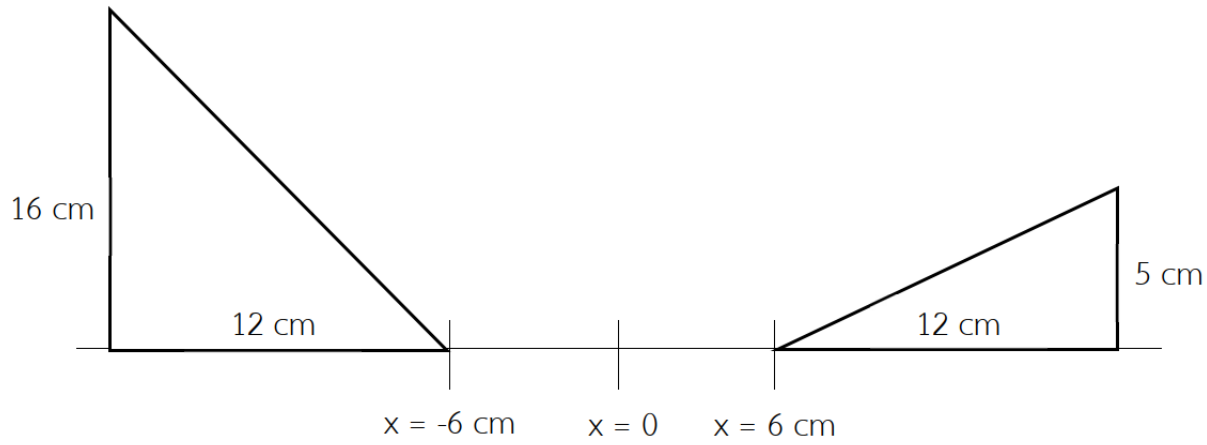
However, the problem is that the actual package basket is placed at a distance of 25 centimeters from the end of the ramp. If the package is to land accurately in the basket, from which point on the ramp should the team release the package? (2.5 marks)

Assume the package rolls without slipping and there is no energy loss along the way.

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

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22. Two waves are moving toward each other at a speed of 5 cm/s, as shown in the figure below.



What is the resultant displacement of the two waves at position x = 0 after 3 seconds? (2.5 marks)

1. 14.75 cm
2. 15.25 cm
3. 15.75 cm
4. 16.25 cm

23. What is the frequency of the first overtone in a 0.5 m string whose two ends are not free to move? Given that the wave speed of the string is 400 m/s. (2.5 marks)

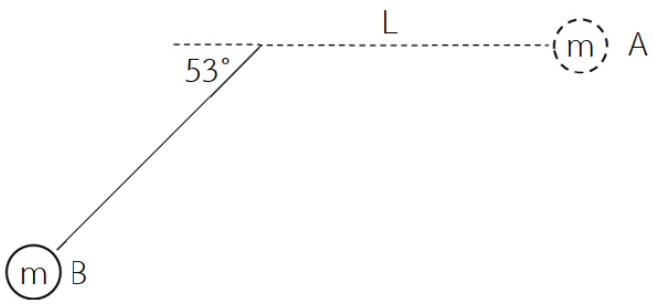
1. 200 Hz
2. 400 Hz
3. 600 Hz
4. 800 Hz

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24. A ball with a mass of 35 kg jumps vertically upward from a stage that is 7.2 m above a trampoline, with a speed of 6 m/s. If the trampoline behaves like a spring with a spring constant of 7 x 10^3 N/m, how much will the trampoline compress due to the child? (2.5 marks)

1. 0.95 m
2. 1.00 m
3. 1.05 m
4. 1.10 m

25. A pendulum of mass *m* is suspended by a string of length *L* and released from position A, as shown in the figure.



What is the tension in the string at the moment it reaches position B? (2.5 marks)

1. 1.2 mg
2. 1.5 mg
3. 1.8 mg
4. 2.4 mg

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26. In an experiment, a student reacted magnesium metal (Mg) with hydrochloric acid (HCl) according to the following balanced equation:

$$Mg\ (s) + 2HCl\ (aq) \longrightarrow MgCl_2\ (aq) + H_2\ (g)$$

The student used 1.20 grams of Mg with 95% purity. The reaction was carried out at 27°C and 740 mmHg. After the reaction, 520 mL of H_2 was collected.

Given : R = 0.0821 L·atm/mol·K

1 atm = 760 mmHg

What is the percent yield of hydrogen gas (H_2) in this experiment? (2.5 marks)

1. 37.8%
2. 44.6%
3. 56.2%
4. 66.0%

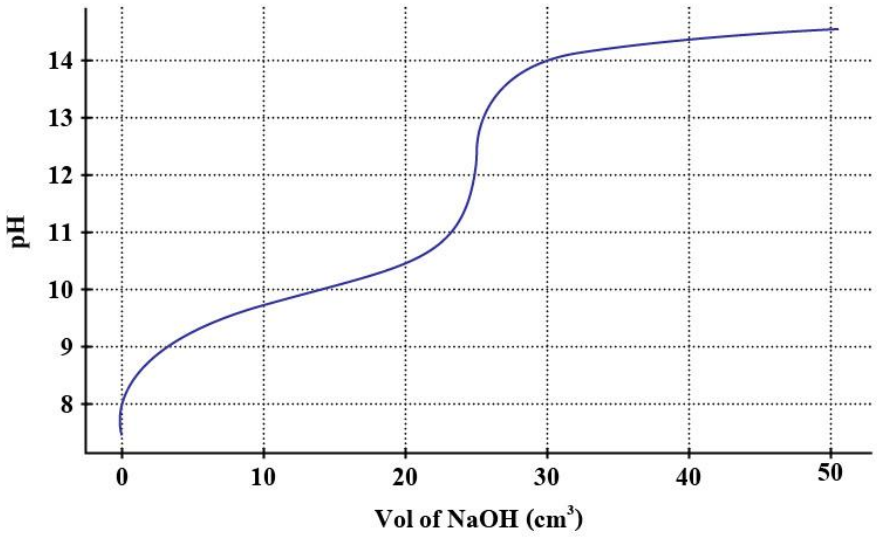
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27. Miraah, a Grade 12 student, is working on a science project on the use of rice bran for producing antioxidant compounds. He extracted γ-Oryzanol from rice bran oil and titrated it with 0.10 mol/dm³ NaOH to determine the pKa of the functional group capable of donating a proton.

Preliminary studies showed that γ-Oryzanol contains a benzene ring with a phenol group (-OH) on ferulic acid, which undergo dissociation as follows:

$$Ar–OH \rightleftharpoons Ar–O^- + H^+$$

Miraah prepared 25.0 ml of γ-Oryzanol solution at the concentration of 0.0050 mol/dm³, and titrated it with 0.10 mol/dm³ NaOH. A pH meter was used to monitor the change in pH as NaOH was gradually added. The graph below shows the pH change during the titration as a function of the volume of NaOH added.



Based on the data in the graph, determine the amount of γ-Oryzanol used in the experiment and calculate the pKa value of the phenol group in γ-Oryzanol. (5 marks)

1. 1.25×10^{-2} mol, pKa = 9.75
2. 1.25×10^{-3} mol, pKa = 11.2
3. 1.25×10^{-4} mol, pKa = 9.75
4. 1.25×10^{-5} mol, pKa = 11.2

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28. Scientists from ASMOPSS EcoVolt are developing a portable clean energy source for use in remote areas, using galvanic cell technology that generates electricity from chemical reactions.

In the prototype of the portable electrochemical cell, zinc (Zn) and copper (Cu) metals are each immersed in their respective solutions of Zn^{2+} and Cu^{2+} ions.

The cell reaction used is :

$$Zn\ (s) \mid Zn^{2+}\ (1.0\ M) \parallel Cu^{2+}\ (1.0\ M) \mid Cu\ (s)$$

standard electrode potential:

$$E^\circ\ Zn^{2+} / Zn = -0.76\ V$$

$$E^\circ\ Cu^{2+} / Cu = +0.34\ V$$

To stabilize the electrochemical cell for longer operation, the research team adjusted the concentration of Cu^{2+} to 0.010 M and used Nernst equation to evaluate the cell's electromotive force (EMF) in the portable power system.

Consider the following statements:

A. The redox reaction of the cell is $Zn\ (s) + Cu^{2+}\ (aq) \longrightarrow Zn^{2+}\ (aq) + Cu(s)$

B. The standard cell potential (E°) is 1.10 V.

C. When the concentration of Cu^{2+} is decreased to 0.010 M, the cell potential increases.

D. If concentration of Zn^{2+} increases beyond 1.0 M, the electromotive force of the cell decreases.

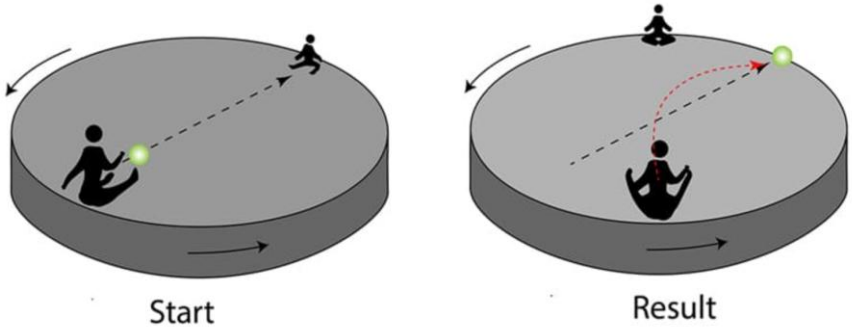
E. Connecting Zn and Cu metals with a conducting wire will cause both Zn and Cu to dissolve into ions.

Which of the following statements is correct? (5 marks)

1. A, B, and C
2. A, B, and D
3. A, C, D, and E
4. All of above

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29. In the diagram below, the first man rolls a ball to his friend, with both sitting on a rotating platform. However, as the ball reaches the side where his friend is seated, it appears to be subjected to a force which causes it to deviate from its original straight path.



From the experiment, which of the following most accurately describes the characteristics of natural weather? (5 marks)

1. The storm moves towards the coast along lines of latitude due to frictional force.
2. The trade winds blow from the northeast in the Northern Hemisphere due to the Coriolis force.
3. Air moves from the poles towards the equator due to the pressure gradient force.
4. Air rises along the equator because of the centripetal force caused by the Earth's rotation.

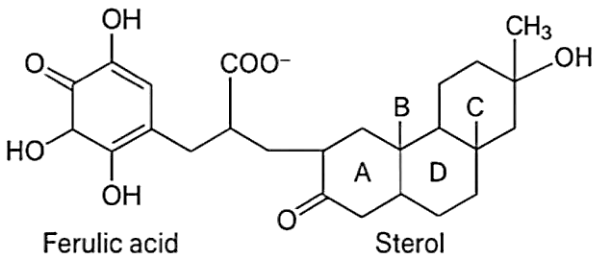
30. If a dry air parcel has a temperature of 25 °C at sea level and begins to rise, becoming saturated at 500 meters, and continues to rise further, what will be the temperature of the air parcel when it reaches an altitude of 2,000 meters? What is the atmospheric stability as the air parcel rises? Assume that the dry adiabatic lapse rate is 1.0 °C per 100 meters and the wet adiabatic lapse rate is 0.6 °C per 100 meters. (5 marks)

1. 9.0 °C absolute stability
2. 11.0 °C absolute instability
3. 15.0 °C conditional instability
4. 18.0 °C neutral stability

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Use the information below to answer Questions 31–32

γ-Oryzanol is a compound found in rice bran oil with interesting chemical properties. The structure of γ-Oryzanol consists of ferulic acid linked to a sterol molecule by an ester bond. The structure of γ-Oryzanol is shown in the figure below.



31. Which of the following statements about the chemical bonds in the structure of γ-Oryzanol is incorrect? (1.25 marks)

A. There is a covalent bond between carbon and oxygen in the ester group.

B. The benzene ring contains **π**-bonds, which are stable and involve delocalized electrons.

C. There are hydrogen bonds between γ-Oryzanol molecules, making it highly water-soluble.

D. No ionic bonds are present in the structure of γ-Oryzanol.

E. γ-Oryzanol contains only non-polar covalent bonds, making it uniformly hydrophobic.

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

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32. Which of the following best describes the structure of γ-Oryzanol? (1.25 marks)

1. γ-Oryzanol contains a primary alcohol group (-OH) that can be oxidized to a ketone group.

2. γ-Oryzanol is a ketone compound, characterized by a carbon-oxygen double bond.

3. γ-Oryzanol has an ester group, which is formed from the reaction between a carboxylic acid and an alcohol.

4. γ-Oryzanol has an aldehyde group, which enables it to react with Benedict's solution.

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33. The research team at Green Fuel Lab is investigating the rate of reaction of ethanol production from glucose, using enzymes as catalysts. The goal is to shorten fermentation time and enhance efficiency of biofuel.

The simplified experimental reaction conducted in the laboratory is as follows:

$$C_6H_{12}O_6 \xrightarrow{\text{enzyme}} 2C_2H_5OH + 2CO_2$$

The research team investigated the reaction rate by measuring the amount of CO_2 produced over various glucose concentrations and time intervals. The experimental results, obtained at constant temperature, are presented in the table below.

[Glucose] (mol/l)	Initial Rate (mol/l*s)
0.100	2.5×10^{-4}
0.200	5.0×10^{-4}
0.400	1.0×10^{-3}

Which of the following best describes this experiment? (2.5 marks)

A. The reaction rate is directly proportional to the concentration of glucose to the first order.

B. If the glucose concentration is increased 4 times, the rate of CO_2 production will increase 8 times.

C. The rate law for this reaction is Rate = k × [Glucose].

D. If the temperature increases by 10°C, the rate constant (k) will approximately double.

E. Increasing the amount of enzyme will increase the rate constant (k), but will not affect the activation energy (Ea).

1. A, C, and D
2. B, D, and E
3. A, C, D, and E
4. All of above

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34. The Earth's internal structure consists of several distinct layers, each differentiated by its chemical composition, physical state, and mechanical properties, as shown in the table.

Earth layer	Physical state	Properties of layers
Lithosphere	solid	hard and rigid outer vertical layer of the Earth, includes both the crust and the lithospheric mantle
Asthenosphere	solid	mostly solid, but contains a small amount of partial melting, making it the primary source of magma on Earth
Mesosphere	solid	more rigid and immobile than the asthenosphere
Outer core	liquid	the only entirely liquid layer of Earth, where molten iron and nickel circulate
Inner core	solid	primarily composed of solid ball of iron with some nickel

Based on the information provided, which of the following best describes the role of each Earth layer in explaining geological phenomena? (2.5 marks)

1. Most earthquakes originate in the mesosphere.
2. Plate tectonics are caused by convection currents solely in the inner core.
3. Volcanic eruptions are mainly caused by magma rising from the lithosphere.
4. The Earth's magnetic field is generated by the movement of fluid in the outer core.

35. Elements P, Q, R, and S are in the same period of the periodic table and have increasing atomic numbers in the order: P < Q < R < S. The following observations are made:

P has the largest atomic radius

Q has the lowest ionization energy

R has the greatest electron affinity

S has the lowest electronegativity

Which of the following correctly represents the order of elements P, Q, R, and S?
(2.5 marks)

1. Na, Al, Cl, Ar
2. Na, Al, Si, Cl,
3. K, Ca, Sc, Ti
4. P, S, Cl, Ar

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36. Consider two earthquake scenarios in Thailand:

Scenario A : An earthquake of magnitude 6.0 with its hypocenter located at a depth of 10 kilometers beneath Chiang Rai Province.

Scenario B : An earthquake of magnitude 6.0 with its hypocenter located at a depth of 100 kilometers beneath the Andaman Sea, approximately 300 kilometers offshore from Phuket.

Based on this information, which of the following scenarios most accurately summarizes the likely damage and its cause? (2.5 marks)

1. Scenario A has a higher chance of generating a tsunami than Scenario B, as the hypocenter is closer to the coast.
2. Scenario B is likely to cause more direct damage to buildings on land than Scenario A.
3. The intensity of ground shaking at the surface in Scenario A is likely to be higher than in Scenario B, because the hypocenter is shallower and located beneath land.
4. Both scenarios have an equal chance of causing damage to the same degree, as they have the same magnitude.

37. Billiard ball A, with a mass of 0.5 kg and moving at a constant speed of 1.8 m/s, strikes ball B, which is initially at rest and has a mass 0.6 kg. As a result of the collision, ball A is deflected at an angle of 60° with a constant speed of 1.2 m/s. Find the speed of ball B after the collision. (5 marks)

1. 0.75 m/s
2. 0.9 m/s
3. 1.323 m/s
4. 1.581 m/s

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38. Since 1750 (pre-industrial era), the radiative forcing of major greenhouse gases (GHGs) is a measure of how these gases have influenced the balance between incoming and outgoing energy in the Earth-atmosphere system. Positive radiative forcing leads to warming, as shown in the table below.

Greenhouse Gas	Radiative Forcing (W/m^2)	Main Human Source
Carbon Dioxide	+2.07	Fossil fuel combustion, deforestation
Methane	+0.50	Agriculture, fossil fuel extraction
Nitrous Oxide	+0.18	Agriculture, industrial processes
Halocarbons	+0.33	Refrigerants, aerosols (now largely phased out)

Based on the data in the table, which of the following statements best summarizes the impact of human activities on the Earth's energy balance? (5 marks)

1. Methane is the most significant greenhouse gas contributing to global warming.
2. Halocarbons, despite their lower concentrations, have a disproportionately large warming effect per molecule compared to CO_2
3. Fossil fuel combustion and deforestation are the largest single contributors to the positive radiative forcing from greenhouse gases.
4. Natural greenhouse gas emissions have a greater radiative forcing than human-caused emissions.

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39. In an era marked by global plastic waste, a team of scientists from BioPlasTech is conducting research on the production of biodegradable soft plastics. They are using natural raw materials, including lactic acid and various alcohols, to synthesize esters, which are key monomers in the production of PLA (polylactic acid) polymers. The esterification reaction in this system is reversible and can be represented by the equation below:

$$CH_3CH(OH)COOH + CH_3OH \rightleftharpoons CH_3CH(OH)COOCH_3 + H_2O$$

To increase the yield of ester, the team conducted laboratory experiments in a closed system at a constant temperature of 60°C. At equilibrium, 0.74 mol of methyl lactate ($CH_3CH(OH)COOCH_3$) was obtained, starting from the following initial conditions:

1.00 mol of lactic acid

1.00 mol of methanol

Constant reaction volume

A small amount of sulfuric acid used as a catalyst

Which of the following statements is correct regarding the esterification reaction in this system? (5 marks)

A. The equilibrium constant of the system at 60°C is 8.10.

B. If 0.50 mol of methanol is added at equilibrium, the system will shift to the left.

C. Removing water from the system during the reaction will help increase the yield of methyl lactate.

D. The ester produced can serve as a monomer in a condensation polymerization process.

E. Using more sulfuric acid as a catalyst will increase the equilibrium constant of the reaction.

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

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40. Based on question 39, researchers at BioPlasTech used diluted sulfuric acid (H_2SO_4) in small amounts as a catalyst. To control product quality and ensure industrial safety, the team designed a pH control system to maintain the reaction pH between 3.0 and 4.0, using a buffer solution.

In the process, the team prepared a 1.00 L buffer solution composed of lactic acid ($C_3H_6O_3$, Ka = 1.38×10^{-4}) and sodium lactate ($NaC_3H_5O_3$) containing 0.200 mol of lactic acid and 0.300 mol of sodium lactate.

Which of the following statements about this process is NOT correct? (5 marks)

A. Based on the data, the pH of the prepared buffer solution is approximately 4.05.

B. If 0.010 mol of HCl is added, the pH will change slightly, and the amount of lactic acid will increase.

C. If 500 mL of water is added to the buffer, the pH will increase because the concentrations of both acid and base decrease.

D. Lactic acid is a suitable buffer because its pKa is close to the desired pH range.

E. If nitric acid is used instead of lactic acid, the buffer will be able to better resist added acid or base.

1. A, B, and D
2. A, C, and E
3. B, D, and E
4. C and E

---------- End of Questions ----------

Please check your answers before submitting the answer sheet.

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คำตอบวิชาวิทยาศาสตร์ ชั้นมัธยมศึกษาปีที่ 6

ข้อ	คำตอบ	ข้อ	คำตอบ
1	3	21	1
2	4	22	3
3	4	23	4
4	3	24	2
5	3	25	4
6	1	26	2
7	3	27	3
8	4	28	2
9	3	29	2
10	3	30	2
11	4	31	4
12	4	32	3
13	2	33	1
14	1	34	4
15	2	35	1
16	4	36	3
17	3	37	3
18	2	38	3
19	1	39	4
20	3	40	4

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