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EDUCATIONAL ASSESSMENT AND EXAMINATION SERVICE

ETHIOPIAN SECONDARY SCHOOL LEAVING CERTIFICATE EXAMINATION (ESSLCE) PHYSICS

TAHISAS 2014/15 (DECEMBER 2022)

BOOKLET CODE: 084
NUMBER OF ITEMS: 50

SUBJECT CODE: 04
TIME ALLOWED: 2 HOURS

GENERAL DIRECTIONS

THIS BOOKLET CONTAINS ***PHYSICS*** EXAMINATION. THE SUBJECT CODE FOR THIS EXAMINATION IS **04** AND THE CODE FOR THIS PARTICULAR BOOKLET IS **084**. PLEASE COPY THESE CODES ON YOUR ANSWER SHEET WHERE IT READS ***BOOKLET CODE*** AND ***SUBJECT CODE***. THEN, BLACKEN THE CORRESPONDING BOXES IN THE COLUMNS BELOW EACH NUMBER.

IN THIS EXAMINATION, THERE ARE A TOTAL OF **50 MULTIPLE CHOICE ITEMS.** ATTEMPT ALL THE ITEMS. FOLLOW THE INSTRUCTIONS ON THE ANSWER SHEET AND THE EXAMINATION PAPER CAREFULLY. USE ONLY **PENCIL** TO MARK YOUR ANSWERS.

THERE IS ONLY **ONE BEST** ANSWER FOR EACH ITEM. CHOOSE THE BEST ANSWER FROM THE SUGGESTED OPTIONS AND BLACKEN THE LETTER OF YOUR CHOICE ON THE ANSWER SHEET. YOUR ANSWER MARK SHOULD BE **HEAVY** AND **DARK**, COVERING THE ANSWER SPACE COMPLETELY. PLEASE ERASE ALL UNNECESSARY MARKS COMPLETELY FROM YOUR ANSWER SHEETS.

YOU WILL BE ALLOWED TO WORK FOR **2 HOURS.** IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY GO BACK AND REVIEW. WHEN TIME IS CALLED, YOU MUST IMMEDIATELY STOP WORKING, LAY YOUR PENCIL DOWN, AND WAIT FOR FURTHER INSTRUCTIONS.

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You may refer to the information given below when you need to work on some of the questions.

Name of constants	Symbol	Value
Acceleration due to gravity	g	10 m/s^2
Mass of proton	m_p	1.67×10^{-27} kg
The charge of electron	e-	1.6×10^{-19} C
Universal gravitational constant	G	6.67×10^{-11} Nm^2/kg^2
Density of water	ρ	1000 kg/m^3
Molar gas constant	R	8.314 J/mol.K
permittivity of vacuum	ε_o	8.85×10^{-12} F/m
Magnetic permeability of free space	μ_o	$4\pi \times 10^{-7}$ Tm/A
Coulomb's constant	k	9×10^9 Nm^2/C^2
Specific heat of lead	C_{lead}	128 J/kg.K
$\sin 15^\circ = 0.26$, $\cos 15^\circ = 0.97$		
$\sin 25^\circ = 0.42$, $\cos 25^\circ = 0.91$		
$\sin 30^\circ = 0.5 = \cos 60^\circ$		
$\sin 37^\circ = \cos 53^\circ = 0.6$		
$\sin 60^\circ = 0.87 = \cos 30^\circ$		
$\sin 79^\circ = 0.98$, $\cos 79^\circ = 0.19$		
$\sin 104^\circ = 0.97$, $\cos 104^\circ = -0.24$		

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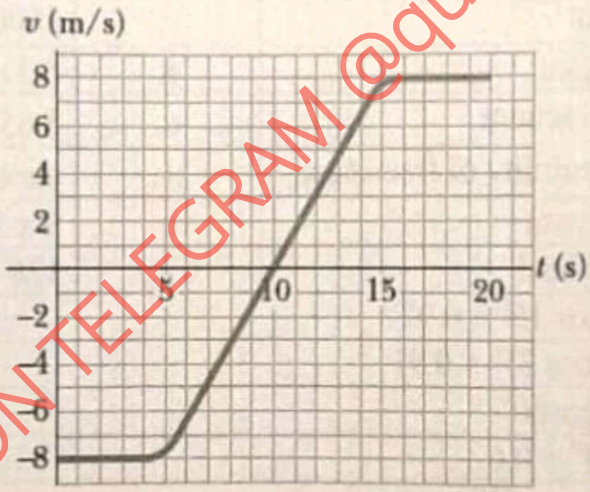
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1. Three forces acting on an object result to a static equilibrium of the object. Which one of the following statements is correct about the forces?

   A. All the three forces are directed in the same direction.
   B. The three forces form a triangle when connected head-to-tail.
   C. Two of the forces are directed parallel to each other while the third is perpendicular to the other two.
   D. Two of the forces are directed anti-parallel to each other while the third is perpendicular to the other two.

2. The velocity-time graph for an object moving along a straight path is shown in the Figure below.



Which one of the following is **NOT** correct about the motion of the object?

   A. The acceleration of the object when t = 10 s is 1.6 m/s^2.
   B. The distance covered by the object during t = 15 s to t = 20 s is 40 m.
   C. The acceleration when t = 2 s is 4 m/s^2.
   D. The total displacement of the object is zero.

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3. The law of conservation of momentum states that

A. the total momentum of an isolated system remains constant.
B. the total momentum and kinetic energy of a system remains constant.
C. the total momentum before collision is larger than the total momentum after collision.
D. the total momentum of an isolated system varies with time.

4. An object is said to be in translational equilibrium, when

A. the object is accelerating with constant acceleration.
B. the object's velocity is changing with time.
C. the sum of all forces acting on the object is zero.
D. the object is rotating in a circle with constant velocity.

5. An object of mass m moving in a straight line with constant acceleration covers a displacement s. During the motion, the object's velocity changes from an initial value u to a final value v. The work done (W) on the object to cover the given displacement is _____.

A. $W=\frac{1}{2}m(v^2+u^2)$
B. $W=\frac{1}{2}m(v-u)$
C. $W=\frac{1}{2}m(v+u)$
D. $W=\frac{1}{2}m(v^2-u^2)$

6. A metallic wedge of 8 cm long and 2 cm wide is pushed into a wooden block to split it into two pieces. An effort of 30 N is applied on the metallic wedge to split a load of 90 N. Which of the following parameters is correct about the wedge?

A. MA = 0.75
B. VR = 0.25
C. $\eta = 75\ \%$
D. VR = 4

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7. Consider a column of mercury of height h and radius r filled with a liquid of density, ρ. If the weight of the liquid inside the column is equal to the force due to the pressure on the bottom of the column, then which one of following is the correct expression for the atmospheric pressure P at a place where the value of gravity is g?

A. ρgr

B. $\frac{\rho gr}{\pi r^2}$

C. $\frac{\rho gr}{\pi h^2}$

D. ρgh

8. A certain rod of length L_0 at temperature T_0 is heated so that its length increases by ΔL when the temperature changes by ΔT. The increase in length is given by $\Delta L = \alpha L_0 \Delta T$, where α is the coefficient of linear expansion. Which of the following statements is correct about the area and volume coefficients of expansion of the same material?

A. The coefficient of area expansion β is equal to $\alpha/2$.
B. The coefficient of area expansion β is equal to α^2.
C. The coefficient of volume expansion γ is equal to 3α.
D. The coefficient of volume expansion γ is equal to $\alpha/3$.

9. How much energy is required to raise the temperature of 5 kg of lead from 20 ^{0}C to its melting point of 327 ^{0}C?

A. 4.04×10^5 J
B. 1.96×10^5 J
C. 1.07×10^5 J
D. 2.13×10^5 J

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10. Which one of the following statements is correct about propagation of waves?

A. Transverse wave occur when the vibrations of the particles are parallel to the direction of propagation of the wave.
B. Longitudinal wave occur when the vibrations of the particles are perpendicular to the direction of propagation of the wave.
C. Transverse wave occur when the vibrations of the particles are perpendicular to the direction of propagation of the wave.
D. A longitudinal wave consists of a series of crests and troughs, while a transverse wave consists of a series of compression and rarefactions.

11. The speed of sound in air at a place where the temperature is 0 °C is 331 m/s. What is its speed when the temperature rises to 30 °C?

A. 331 m/s
B. 361 m/s
C. 346 m/s
D. 349 m/s

12. Suppose a ball is thrown at a certain angle with the horizontal. Which one of the following statements is NOT correct about its velocity?

A. The vertical component of the velocity decreases on the way up.
B. The horizontal component of the velocity remains unchanged on the way up or down.
C. The vertical component of the velocity increases on the way down.
D. The velocity of the ball attains its maximum value at the top of the trajectory.

13. The moment of inertia of a rotating object is 0.06 kg.m^2. If its angular velocity is 0.4 rad/s, what is its rotational kinetic energy?

A. 1.2×10^{-2} J
B. 4.8×10^{-3} J
C. 9.6×10^{-3} J
D. 7.2×10^{-4} J

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14. A student performs an experiment to charge a neutral electroscope using either induction or conduction. Which of the following statements is correct about the charge on the electroscope? The charge on an electroscope that is charged by

A. bringing it into contact with a positively charged rod is negative.
B. induction using a negatively charged rod is negative.
C. bringing it into contact with a negatively charged rod is positive.
D. induction using a positively charged rod is negative.

15. Coulomb's law states that the magnitude of the electrostatic force between two point charges

A. is inversely proportional to the product of the magnitudes of the charges and directly proportional to the square of the distance between them.
B. is directly proportional to the product of the magnitudes of the charges and inversely proportional to the distance between them.
C. is inversely proportional to the product of the magnitudes of the charges and directly proportional to the distance between them.
D. is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between them.

16. A wire has a length of 100 m long and a cross-sectional area of 1.2×10^{-6} m^2. If its resistivity is 4.8×10^{-8} Ω.m, what is the resistance of the wire?

A. 2 Ω
B. 4 Ω
C. 0.5 Ω
D. 0.25 Ω

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17. A 1.5 kW electrical stove operating at full power is used for cooking food. If the electrical energy costs 30 cents per kWh, what is the total cost of operating the stove for 4 hours?

A. 180 cents
B. 45 cents
C. 90 cents
D. 135 cents

18. Suppose a straight conductor of length l is placed in a uniform external magnetic field B making an angle of θ with B. If the charge that flows in the conductor in time t is q, then the magnitude of the magnetic force on the conductor is _____.

A. $F = \frac{qlB \sin\theta}{t}$
B. $F = qlB \sin\theta$
C. $F = qlB \sin\theta$
D. $F = \frac{qB \sin\theta}{l}$

19. During electromagnetic induction, "the direction of the induced current is in such a way to oppose the change that causes it". This is a statement of

A. Faraday's law.
B. Lenz's law.
C. Gauss's law.
D. Ampere's law.

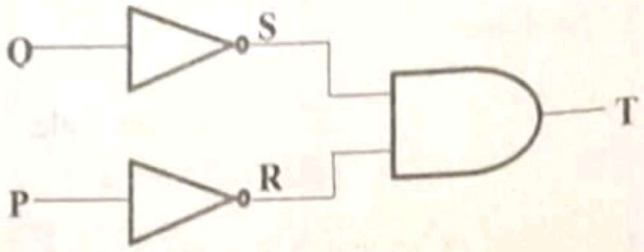
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20. Consider the arrangements of gates shown in the figure below.



Which of the following is the correct truth table for the arrangement?

A.

P	Q	R	S	T
0	0	0	0	0
0	1	0	1	0
1	0	1	0	0
1	1	1	1	1

C.

P	Q	R	S	T
0	0	1	1	0
0	1	1	0	1
1	0	0	1	1
1	1	0	0	0

B.

P	Q	R	S	T
0	0	1	1	1
0	1	1	0	0
1	0	0	1	0
1	1	0	0	0

D.

P	Q	R	S	T
0	0	1	1	1
0	1	1	0	1
1	0	0	1	1
1	1	0	0	0

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21. An object is placed 16.0 cm away from a concave mirror with focal length 6.00 cm. What is the position and nature of the image formed?

A. 9.60 cm in front of the mirror and real
B. 4.36 cm in front of the mirror and real
C. 9.60 cm behind the mirror and virtual
D. 4.36 cm behind the mirror and virtual

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22. Suppose light is travelling from a pond full of water to air. Total internal reflection occurs when

A. the angle of incidence is equal to 45^0.
B. the angle of incidence is less than the critical angle.
C. the angle of incidence is equal to 90^0.
D. the angle of incidence is greater than the critical angle.

23. Which of the following statements about precision and accuracy is correct?

A. Accuracy is a measure of the exactness of the measurement value while precision is the closeness of a measurement about its true value.
B. Accuracy is the closeness of a measurement about its true value while precision is a measure of the exactness of the measurement value.
C. Measurements which are far from each other but are close to the true value are precise but not accurate.
D. Measurements which are close to each other but are quite far from the true value are accurate but not precise.

24. Two vectors have magnitudes $\vec{P}$ = 6 units and $\vec{Q}$ = 8 units. If the angle between the vectors is 60^0, what is the magnitude of the resultant vector?

A. 6.9 units
B. 11.1 units
C. 12.2 units
D. 14.0 units

25. Suppose you are given two vectors $\vec{P} = 2i + 4j + k$ and $\vec{Q} = 3i - 3j + \alpha k$, where α is unknown constant. If the two vectors are orthogonal, then the value of α is_____.

A. 6
B. -6
C. 18
D. -1

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26. A car accelerates from an initial velocity u to a final velocity v, during which it covers a displacement s. What is its acceleration?

A. $a=\frac{v-u}{s}$

B. $a=\frac{v^2-u^2}{s}$

C. $a=\frac{v^2-u^2}{2s}$

D. $a=\frac{v^2+u^2}{s}$

27. A certain string can withstand a maximum tension of 40 N without breaking. A child ties a 0.37 kg stone to one end and, holding the other end, whirls the stone in a vertical circle of radius 0.91 m, slowly increasing the speed until the string breaks. Where the stone on its path and what is its speed when the string breaks, respectively?

A. At the bottom of the circle and its speed is 10.4 m/s.
B. At the top of the circle and its speed is 10.4 m/s.
C. At the bottom of the circle and its speed is 9.5 m/s.
D. At the top of the circle and its speed is 9.5 m/s.

28. A person pushes horizontally with a force of 220 N on a 55 kg crate to move it across a level floor. The coefficient of kinetic friction between the crate and the floor is 0.35. Which of the following is correct about the motion of the crate?

A. The magnitude of the acceleration of the crate is 0.50 m/s^2.
B. The magnitude of the frictional force on the crate is 178 N.
C. The magnitude of the frictional force on the crate is 77 N.
D. The magnitude of the acceleration of the crate is 7.43 m/s^2.

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29. A rocket whose initial mass M_i consumes fuel at the rate of $R = \Delta m/\Delta t$. If the speed of the exhaust gases relative to the rocket engine is v, then what thrust force (F) does the rocket engine provide?

A. $F=M_iv$
B. $F=M_iRv$
C. $F=M_iv/R$
D. $F=Rv$

30. A 0.70 kg block is released from rest at height h_0 above a vertical spring with spring constant k = 400 N/m and negligible mass. The block sticks to the spring and momentarily stops after compressing the spring 0.28 m. What is the value of h_0?

A. 1.14 m
B. 1.34 m
C. 0.94 m
D. 0.20 m

31. Which of the following statements about forces is correct?

A. A force that does work when a body moves on a closed circle is conservative force.
B. If the work done on an object is independent of the path, then the force is conservative.
C. Gravitational force is an example of dissipative forces.
D. The work done by dissipative forces is positive.

32. Which of the following is **NOT** among the factors that affect the moment of inertia of a rotating object?

A. The mass of the object
B. The location of the axis of rotation
C. The mass distribution from the axis of rotation
D. The angular speed of the object

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33. A solid, horizontal cylinder of moment of inertia is 5 kg.m^2 about a fixed vertical axis through its center rotates with an angular speed of 7.00 rad/s. A 0.25-kg piece of putty is dropped vertically onto the cylinder at a point 0.900 m from the center of rotation and sticks to the cylinder. What is the final angular speed of the system?

A. 6.73 rad/s
B. 6.86 rad/s
C. 7.00 rad/s
D. 7.30 rad/s

34. A small moment acting perpendicular to the top surface of a bottle lying on its side on a horizontal floor will cause the bottle to roll over the floor. When the moment is removed, the bottle will come to rest in a new position because of friction between the floor and the bottle. Then, which of the following statements is correct about the condition of stability of the bottle? It is in

A. a stable equilibrium.
B. a neutral equilibrium.
C. an unstable equilibrium.
D. a dynamic equilibrium.

35. Which of the following statements about liquids is **NOT** correct?

A. Surface tension is the property of a liquid surface that causes it to act like a stretched elastic skin.
B. Surface energy is a measure of the disruption of intermolecular bonds caused by a surface.
C. Surface tension is a cohesive effect at the surface of a liquid due to the forces between the liquid's molecules.
D. Surface energy is the property of a liquid surface that causes it to act like a stretched elastic skin.

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36. A spherical object of diameter 10^{-3} m is falling through a viscous liquid of viscosity 0.85 with a velocity 40 cm/s. The viscous (drag) force acting on the object is

A. 6.4×10^{-3} N.
B. 3.2×10^{-3} N.
C. 6.4×10^{-2} N.
D. 3.2×10^{-2} N.

37. The rate of flow of heat energy through a conducting object does **NOT** depend on

A. the density of the object.
B. the cross-sectional area along the direction of flow.
C. the type of the material from which the object made of.
D. the temperature gradient along the direction of flow.

38. For an ideal gas the molar heat capacity at constant volume (C_V) is given by $C_V = 3R/2$, where R is the molar gas constant. Which one of the following is correct about the molar heat capacity at constant pressure (C_P)?

A. $C_P = 3R/2$
B. $C_P = 5C_V/2$
C. $C_P = 5R/2$
D. $C_P = 3C_V/2$

39. The square root of the mean of all the squares of the speeds of particles in a gas is known as

A. mean free path.
B. root mean square speed.
C. mean squared speed.
D. square root of the mean speed.

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40. A mass on a string of unknown length oscillates as a pendulum with a period of T. Which one of the following is correct about the motion of the pendulum? The period is

A. 2T when the mass is doubled.
B. 2T when the string length is doubled.
C. T/4 when the string length is halved.
D. T when the amplitude is doubled.

41. A certain vibrating string on a piano has a length of 74 cm and forms a standing wave having two antinodes. What is the wavelength of this wave?

A. 148 cm
B. 98.7 cm
C. 74 cm
D. 37 cm

42. Light of wavelength 624 nm is incident perpendicularly on a soap film of index of refraction (n) 1.33 suspended in air. What is the least (minimum) thickness of the film for which the reflections from the film undergo fully constructive interference?

A. 2.5 μm
B. 1.2 μm
C. 0.12 μm
D. 0.75 μm

43. Consider a solid conducting sphere of radius R. If the sphere is charged, then which of the following is correct about the electric field inside or outside the sphere?

A. The electric field inside the sphere is zero.
B. The electric field inside the sphere increases as the distance from the center increases.
C. The electric field inside is equal to that on the surface of the sphere.
D. The electric field at the center is larger than that on the surface of the sphere.

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44. Consider a parallel plate capacitor that consists of two parallel conducting plates, each with area A and separated by a distance d. If the space between the plates is filled with a dielectric of dielectric constant ε_r and the charge on each capacitor is Q, then what is the capacitance (C) of the capacitors?

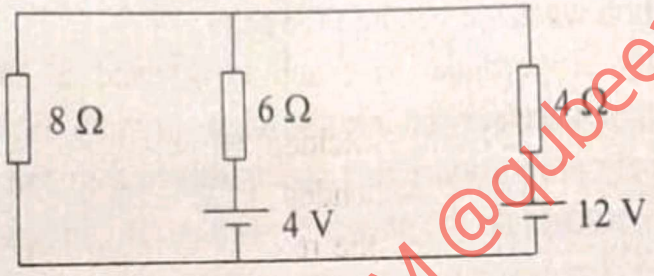
A. $\frac{\varepsilon_0 \varepsilon_r A}{d}$

B. $\frac{\varepsilon_0 \varepsilon_r d}{A}$

C. $\frac{\varepsilon_r A}{d}$

D. $\frac{\varepsilon_0 d}{A}$

45. Consider the circuit shown in the Figure below.



Which one of the following is NOT correct about the current in the resistors of circuit?

A. The current in the 8 Ω resistor is 0.846 A, downward.

B. The current in the 6 Ω resistor is 0.462 A, downward.

C. The current in the 4 Ω resistor is 1.310 A, upward.

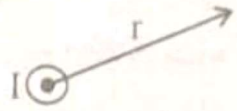
D. The current in the 8 Ω resistor is 0.462 A, upward.

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46. Suppose a long straight wire placed perpendicular to the plane of this page carries a current I directed out of the page as shown in the Figure below.



Which one of the following is correct about the magnetic field created at a distance r from the wire? The magnitude of the magnetic field is

A. directly proportional to r and is directed in the clockwise direction when viewed into the page.
B. inversely proportional to r and is directed in the counterclockwise direction when viewed into the page.
C. directly proportional to r and is directed in the counterclockwise direction when viewed into the page.
D. inversely proportional to r and is directed in the clockwise direction when viewed into the page.

47. Which of the following factors does NOT affect the self-inductance of a coil in a circuit?

A. Magnetic flux through the coil
B. Number of turns of the coil
C. Current passing through the coil
D. The coil's position in a circuit

48. A 90 Ω resistor is connected in series with a 180 mH inductor and an alternating source of 12 V and frequency 60 Hz. Which of the following is correct about the circuit parameters?

A. The impedance of the circuit is 121.7 Ω.
B. The reactance of the circuit is 67.8 Ω.
C. The phase angle between the supply voltage and the current is $\theta = 53^0$.
D. The power factor of the circuit is 0.6.

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49. Which of the following is correct about photoelectric effect?

A. It occurs when a metal surface shone with ultraviolet light emit electrons.

B. It occurs when a metal surface is heated by an electric heater thereby emitting electrons.

C. The frequency of photoelectrons is proportional to the strength of the incident radiation.

D. Photoelectric effect is an example of the wave nature of light.

50. Consider a region of space where both electric and magnetic fields are present. Which one of the following is correct about the effect of the fields on nuclear (alpha, beta, and gamma) radiations?

A. Both alpha and beta particles moving in the region are deflected by both the electric and magnetic fields.

B. A gamma ray travelling in the region is deflected by the magnetic field, while a beta particle moving in the region is not affected by both the electric and magnetic fields.

C. A gamma ray travelling in the region is deflected by the electric field, while an alpha particle moving in the region is not affected by both the electric and magnetic fields.

D. Both alpha and beta particles moving in the region are affected by neither the electric field nor the magnetic field.

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