SC5122&1
WASSCE 2020
PHYSICS 2&1
Essay and Objective
2¾ hours

2&1

Name ....

Index number ....

THE WEST AFRICAN EXAMINATIONS COUNCIL

West African Senior School Certificate Examination
for School Candidates

SC 2020   PHYSICS 2 & 1   2¾ hours

Do **not** *open this booklet until you are told to do so. While you are waiting, read the following instructions carefully. Write your* **name** *and* **index number** *in ink in the spaces provided above.*

This booklet consists of **two** *papers. Answer Paper* **2** *which comes first, in your answer booklet and Paper* **1** *on your Objective Test answer sheet. Paper* **2** *will last* **1½** *hours after which the answer booklets will be collected. Do* **not** *start Paper* **1** *until you are told to do so. Paper* **1** *will last* **1¼** *hours.*

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PAPER 2
ESSAY
[60 marks]   1½ hours

Answer **eight** *questions in all;* **five** *questions from Part* **I** *and* **three** *questions from Part* **II**.

PART I
[15 marks]

Answer any **five** *questions from this part.*

All *questions carry* **equal** *marks.*

1. A varying force **F** applied to a spring produces corresponding extension e, in the spring.
    (a) State **two** quantities that can be deduced from a graph of F against e within the elastic limit of the spring.

    (b) Show how any of the quantities stated in (a) could be obtained from the graph.
                                                                    [3 marks]

2. (a) State **two** dangers associated with improper use of lasers.

    (b) State **one** safe way of using lasers.
                                                                    [3 marks]

3. Give the reason for using
    (a) steel as a compass needle.

    (b) soft iron as a core of electromagnets.
                                                                    [3 marks]

4. The electrical resistance of a semiconductor decreases with increase in temperature. Use the band theory to explain this observation.
                                                                    [3 marks]

5. A bullet is fired from a gun at 30° to the horizontal. The bullet remains in flight for 25 s before touching the ground. Calculate the velocity of projection.
    [**g** = 10 m s^{-2}]   [3 marks]

6. A satellite launched with velocity V_E just escapes the earth's gravitational attraction. Given that the radius of the earth is R, show that $V_E = \sqrt{20R}$.
                                                                    [3 marks]

7. (a) What is a *black body*?

    (b) Sketch the graphs of intensity against wavelength for a black body radiations at temperatures 1000 K and 2000 K on the same axes.
                                                                    [3 marks]

PART II
[45 marks]

Answer **three** *questions from this part.*
All *questions carry* **equal** *marks.*

8. (a) (i) Define *friction*.

(ii) State **two** situations **each** for which friction is considered to be:

(α) desirable;

(β) undesirable.

[6 marks]

(b) (i) State the **two** conditions fulfilled by a body undergoing simple harmonic motion.

(ii) A pendulum of length 130.0 cm has a period of oscillation, T_1. The bob is pulled and released to move in a horizontal circle of radius 50.0 cm. If the period of rotation is T_2, calculate the ratio $T_1 : T_2$.

[$g = 10$ m s^{-2}, $\pi = 3.142$]

[7 marks]

(c) A lorry and a car with the same kinetic energy are brought to rest by application of equal retarding forces. Explain why the two vehicles will cover the same distance before coming to rest.

[2 marks]

9. (a) (i) Explain *magnetic saturation*.

(ii) State **two** methods of demagnetizing a magnet.

[4 marks]

(b) (i) Define *electrical power*.

(ii) An electric heating coil of resistance R is immersed in 1 kg of water at 20 °C. The coil is connected in series with a resistor Y across a 240 V mains supply. The temperature of the water rises to the boiling point in 10 minutes. When Y is disconnected, the time taken for the 1 kg of water at the same temperature to boil is reduced to 6 minutes. Neglecting all heat losses, calculate the resistance R_Y of Y.

[Specific heat capacity of water = 4200 J kg^{-1} K^{-1}]

[7 marks]

(c) (i) State and explain the effect of doubling the number of turns of the coil without changing the frequency of rotation on the output voltage of an a.c. generator.

(ii) Illustrate the effect in (i) on a graph of e.m.f. against time for one complete rotation.

Turn over

10.   (a)   (i)   Define a *wave*.
         (ii)   Differentiate between *transverse waves* and *longitudinal waves*.

[4 marks]

      (b)   A source of sound of frequency 550 Hz emits waves of wavelength 600 mm in air at 20 °C. Calculate the:
         (i)   speed of sound at this temperature;
         (ii)   wavelength of the sound at 0 °C.

[6 marks]

      (c)   State:
         (i)   **three** defects of the eye;
         (ii)   the type of lens used to correct **each** of the defects stated in (i).

[3 marks]

      (d)   State **one**:
         (i)   advantage of using a convex mirror as a driving mirror;
         (ii)   disadvantage of using a convex mirror as a driving mirror.

[2 marks]

11.   (a)   In an experiment to measure the specific latent heat of vaporization of water, a student places a heater in a beaker containing water. The beaker stands on an electronic balance so that the mass of the beaker and water could be measured. The heater is switched on and the reading taken every 100 s when the water starts boiling. The table below shows the readings.

Time/s	0	100	200	300	400
Reading on balance/g	203.22	201.62	199.79	198.26	196.50
Mass of water evaporated/g	0				

         (i)   Copy and complete the table.
         (ii)   Given that the heater supplies energy at the rate of 38 J s^{-1}, add to your table, values of the energy supplied by the heater in 100 s, 200 s, 300 s and 400 s.
         (iii)   Plot a graph of energy supplied on the vertical axis and mass of water evaporated on the horizontal axis, starting both axes from the origin (0, 0).
         (iv)   Determine the slope of the graph.
         (v)   What does the value of the slope mean?

[12 marks]

      (b)   (i)   Explain what is meant by *saturated vapour pressure*.
         (ii)   State the factor that affects saturated vapour pressure.

[3 marks]

12. (a) (i) Explain the statement *light is quantized*.
(ii) Define *work function*.
(iii) When light of frequency 5.4×10^{14} Hz is incident on a metal surface, the maximum energy of the emitted electrons is 1.2×10^{-19} J. Calculate the **minimum** frequency of radiation for which electrons can be emitted. [h = 6.6×10^{-34} J s]

[7 marks]

(b) Define **each** of the following terms:
(i) Atomic number;
(ii) Mass number.

[2 marks]

(c) Radon has mass number 222 and atomic number 86. Radon decays by emitting two beta particles to form radium-222.
Write:
(i) the symbol for radon nuclide;
(ii) an equation to represent the decay process.

[3 marks]

(d) State **three** properties of x-rays.

[3 marks]

END OF ESSAY TEST

Turn over

*Answer **all** the questions.*

Each question is followed by four options lettered A *to* D. *Find the **correct** option for **each** question and shade in **pencil** on your answer sheet, the answer space which bears the same letter as the option you have chosen. Give only **one** answer to **each** question. An example is given below.*

A body starts moving with a speed of 40 m s⁻¹ and accelerates uniformly to 90 m s⁻¹ in 4.0 s. Calculate the distance travelled.

    A.   100 m
    B.   180 m
    C.   200 m
    D.   260 m

The correct answer is 260 m *, which is lettered* D, *and therefore answer space* D *would be shaded.*

    ⊏A⊐   B   ⊏C⊐   ▬D▬

Think carefully before you shade the answer spaces; erase completely any answer(s) you wish to change.

Do all rough work on this question paper.

Now answer the following questions.

1.   In a collision between two objects, kinetic energy is conserved only if
    A.   one of the objects is initially at rest.
    B.   potential energy is converted to work.
    C.   the collision is elastic.
    D.   the collision is inelastic.

2.   The quantity of motion of a body is its
    A.   acceleration.
    B.   momentum.
    C.   displacement.
    D.   velocity.

3.   The volume of a fixed mass of a gas varies inversely as the pressure on it provided the temperature is constant. This statement is
    A.   General gas law.
    B.   Boyle's law.
    C.   Charles' law.
    D.   Pressure law.

4.   An image formed on a screen is always
    A.   virtual.
    B.   upright.
   C.   magnified.
    D.   inverted.

5. How would the capacitance of a parallel plate capacitor be affected if the distance of separation of its plates is decreased? It would
   A. drop to zero.
   B. remain unchanged.
   C. decrease slightly.
   D. increase in value.

6. Which of the following machines does **not** apply the lever principle?
   A. Sugar tong
   B. Single pulley
   C. Wheelbarrow
   D. Claw hammer

7. The average distance moved by a molecule between collisions is called
   A. molecular distance.
   B. intermolecular distance.
   C. mean free path.
   D. mean distance.

8. Which of the following waves require a material medium for its propagation?
   A. Radio waves
   B. Sound waves
   C. X-rays
   D. Light waves

9. The depolarizing agent in a Leclanché cell is
   A. zinc plate.
   B. manganese(IV) oxide.
   C. ammonium chloride.
   D. carbon rod.

10. The material used to slow down the neutrons in a nuclear reactor is
    A. uranium.
    B. graphite.
    C. copper.
    D. boron.

11. Which of the following statements explains why hot soapy water is more effective in cleaning oil-stained dishes?
    A. Soap increases the surface tension of oil and water.
    B. Hot water increases the surface tension of oil.
    C. Soap and heat decrease the surface tension of water.
    D. The oil on the dishes repels the soap.

Turn over

12.
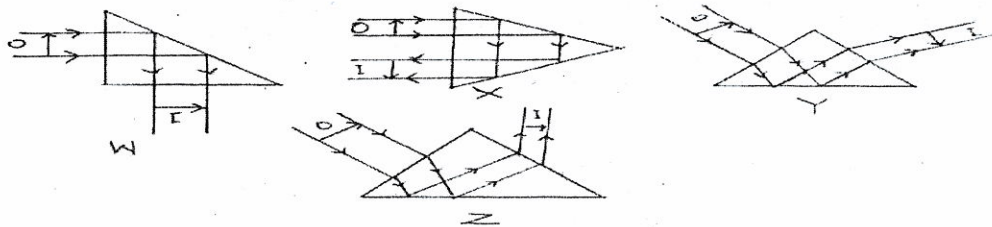
The diagrams above illustrate a beam of parallel rays from a distant object O, incident on one side of total reflecting prism. Which diagram does **not** represent the **correct** path of the beam when it emerges from the prism?

A.   Z
B.   Y
C.   X
D.   W

13. An electrical device has 50 turns in its primary coil and 20 turns in the secondary coil. The device can be

A.   an a.c. generator.
B.   a d.c. generator.
C.   a step-down transformer.
D.   a step-up transformer.

14. The earpiece of a telephone handset converts energy from

A.   electrical to sound.
B.   sound to electrical.
C.   radio wave to sound.
D.   sound to radio wave.

15. Two identical cups containing the same volume of water at 45 °C and 5 °C respectively, are left in a room at 25 °C. Which of the following graphs **correctly** illustrates the variation of temperature with time?
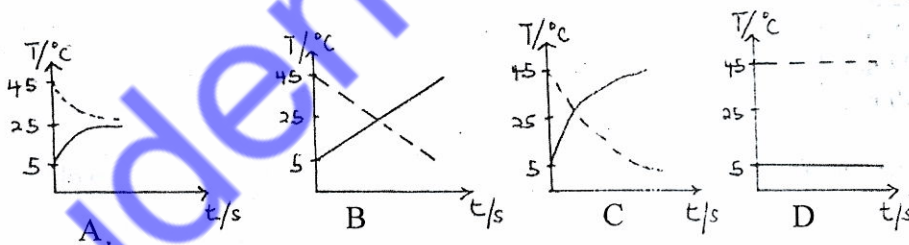

16. A ray of light travelling from glass into ethyl alcohol is incident at the boundary at an angle of incidence 30°. Calculate the angle of refraction.
[refractive index of glass = 1.5; refractive index of ethyl alcohol = 1.36]

A.   72.8°
B.   51.7°
C.   33.5°
D.   27.0°

17. A 60 kg man stands on a weighing balance in an elevator. If the elevator accelerates upwards at 5 m s^{-2}, determine the reading of the scale.

A.   900 N
B.   800 N
C.   600 N
D.   300 N

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18. The length of an iron bar is 100 cm at 20 °C. At what temperature will its length increase by 0.01 %? [Linear expansivity of iron = 1.2×10^{-5} °C^{-1}]
   A. 23.0 °C
   B. 28.3 °C
   C. 38.0 °C
   D. 48.0 °C

19. A moving-coil galvanometer which gives a full-scale deflection with 0.005 A is converted to a voltmeter reading up to 5 V using an external resistor of 975 Ω. What is the resistance of the meter?
   A. 250.00 Ω
   B. 25.00 Ω
   C. 2.50 Ω
   D. 0.25 Ω

20. A beam consisting of α-particles, β-particles and γ-rays pass through a magnetic field at right angles to the direction of the field. Which of the following observations would be made about the α-particles, β-particles and γ-rays respectively?
   A. Deflected, deflected, deflected
   B. Deflected, deflected, not deflected
   C. Deflected, not deflected, deflected
   D. Not deflected, deflected, deflected

21. A parallel plate capacitor is charged and the charging battery subsequently disconnected. If the plates of the capacitor are moved farther apart by means of insulating handles, the
   A. capacitance would increase.
   B. capacitance would decrease.
   C. charge on the capacitor would increase.
   D. charge on the capacitor would decrease.

22. The velocity of sound in air at 15 °C is 340 m s^{-1}. Calculate the velocity at 47 °C.
   A. 322 m s^{-1}
   B. 358 m s^{-1}
   C. 602 m s^{-1}
   D. 790 m s^{-1}

23. Which of the current-voltage characteristics shown below is that exhibited by an ohmic conductor?
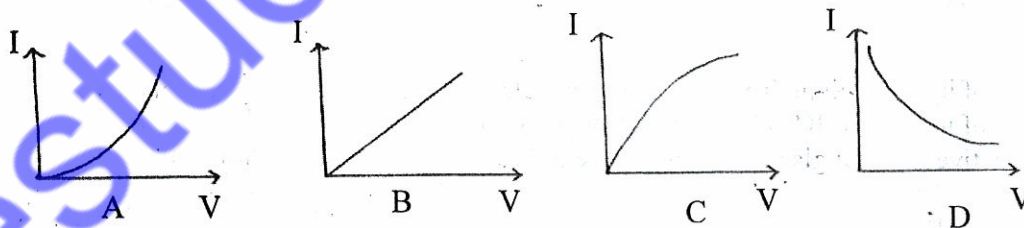
24. A 500 N box rests on a horizontal floor. A constant horizontal force is exerted on the box so that it moves through 8 m. If the coefficient of kinetic friction between the floor and the box is 0.22, calculate the work done on the box.
   A. 110 J
   B. 400 J
   C. 440 J
   D. 880 J

Turn over
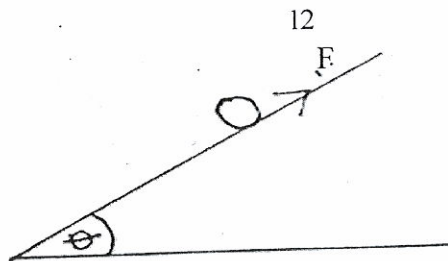
The diagram above illustrates a ball of mass m sliding down a plank inclined at an angle of θ to the horinzontal. The kinetic friction between the ball and the plank is **F** and acceleration of free fall is **g**. *Use this information to answer questions 25 and 26.*

25. The normal force on the ball is
    A. $mg \sin\theta$.
    B. $mg \tan\theta$.
    C. $mg \cos\theta$.
    D. $mg \cot\theta$.

26. The net force on the ball along the plank is
    A. $mg \sin\theta + \mathbf{F}$.
    B. $\mathbf{F} - mg \cos\theta$.
    C. $mg \sin\theta - \mathbf{F}$.
    D. $\mathbf{F} + mg \cos\theta$.

27. What factors determine the frequency of a note emitted by a vibrating string?
    A. Amplitude of vibration, force constant of string, length of string
    B. Amplitude of vibration, force constant of string, tension in string
    C. Mass per unit length of string, tension in string, length of string
    D. Force constant of string, tension in string, length of string

28. The magnitude of the force experienced by a charge of 1.6×10^{-8} C in a uniform electric field of intensity 5×10^5 N C^{-1} is
    A. 3.1×10^{13} N.
    B. 8.0×10^3 N.
    C. 8.0×10^{-3} N.
    D. 3.2×10^{-14} N.

29. Which of the following statements about viscosity is **not** true. It
    A. depends on areas of the surfaces in contact.
    B. is independent of the relative velocity of the layers.
    C. occurs in fluids.
    D. depends on the tangential force between the layers.

30. A motorcycle starting from rest, is uniformly accelerated such that its velocity in 10 s is 72 km hr^{-1}. What is its acceleration?
    A. 2 m s^{-2}
    B. 4 m s^{-2}
    C. 86 m s^{-2}
    D. 108 m s^{-2}

31. The temperature of an object is raised by 120 °C. The resulting increase in its absolute temperature is
    A. 393 K.
   B. 200 K.
    C. 120 K.
    D. 50 K.

32. Which of the following statements about the motion of a simple pendulum is **true**?
    A.   It swings faster at the poles than at the equator.
    B.   It possesses maximum kinetic energy at the extreme positions.
    C.   It passes the equilibrium position with minimum speed.
    D.   It is a simple harmonic motion when the angle of displacement is large.

33. An electron of mass m and charge e moves in a circular path in a magnetic field of flux density **B**. How long does it take to complete one orbit?

    A. $\dfrac{2me}{\mathbf{B}\pi}$

    B. $\dfrac{2\mathbf{B}}{me\pi}$

    C. $\dfrac{2\pi m}{\mathbf{B}e}$

    D. $\dfrac{\mathbf{B}e}{2m\pi}$

34. Which of the following statements about photoelectrons is **correct**?
    A.   A faint green light produces photoelectrons with less kinetic energy than bright red light.
    B.   A red light releases a smaller number of electrons than a green light.
    C.   A faint green light produces photoelectrons with greater kinetic energy than a bright red light.
    D.   A red light releases a greater number of electrons than a green light.

35.

Temp/°C

150

100

4

8 x 10³   53 x 10³   55 x 10³   Heat/J
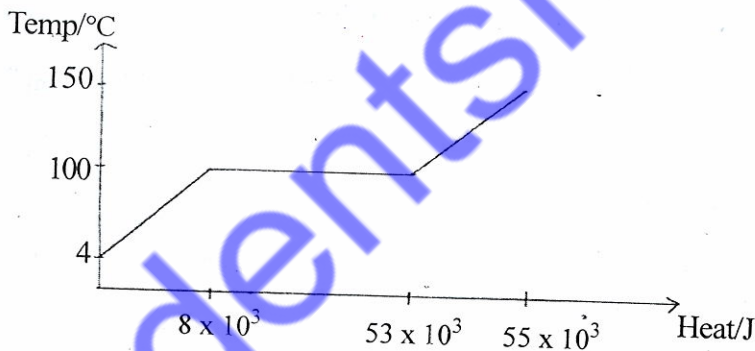
The sketched graph above illustrates the heating curve of a 0.02 kg of water. Determine the approximate value of the specific latent heat of vaporization of water.
    A. 1.00×10^3 J kg^{-1}
    B. 2.00×10^3 J kg^{-1}
    C. 4.17×10^3 J kg^{-1}
    D. 2.25×10^6 J kg^{-1}

36. In the hydraulic press, the force **F** applied is related to the diameter d of the cylinder by
    A. $\mathbf{F} \propto d^{-2}$.
    B. $\mathbf{F} \propto d^{-1}$.
    C. $\mathbf{F} \propto d$.
    D. $\mathbf{F} \propto d^2$.

Turn over

37. In an electric circuit, an inductor of inductance 0.5 H and resistance 50 Ω is connected to an alternating current source of frequency 60 Hz. Calculate the impedance of the circuit.
    A. 1950.1 Ω
    B. 195.0 Ω
    C. 150.5 Ω
    D. 50.0 Ω

38. Which of the following statements **correctly** explains why a total solar eclipse would be seen by people on only a small portion of the earth surface. The
    A. moon is larger in diameter than the earth.
    B. earth is larger in diameter than the moon.
    C. earth is larger in diameter than the sun.
    D. earth revolves round the sun.

39. Water waves have a wavelength of 3.6 cm and speed of 18 cm s^{-1} in deep water. If the waves enter shallow water with wavelength of 2.0 cm, calculate the speed of the waves in the shallow water.
    A. 10.8 cm s^{-1}
    B. 10.0 cm s^{-1}
    C. 2.5 cm s^{-1}
    D. 0.4 cm s^{-1}

40. An a.c. generator can be converted to a d.c. electric motor by replacing the
    A. slip rings with a split ring and connecting a battery.
    B. split ring with slip rings and connecting a battery.
    C. a.c. with d.c. source and connecting slip rings.
    D. a.c. with d.c. source and connecting split rings.

41. A ray of light travels obliquely from a less dense medium to a denser medium. Which of the following statements is **true** about the light?
    A. The wavelength of the light increases in the second medium.
    B. The speed of the light increases in the second medium.
    C. The light refracts towards the normal.
    D. There is a change in the frequency of the light.

42. An electron of mass 9.1×10^{-31} kg is travelling at a speed of 2×10^6 m s^{-1}. Calculate the associated wavelength of the electron. [h = 6.6×10^{-34} J s]
    A. 6.89×10^{-4} m
    B. 3.63×10^{-7} m
    C. 3.63×10^{-8} m
    D. 3.63×10^{-10} m

43. Which of the following statements about the process of melting of a solid are **true**? The temperature of the solid will
    I. remain steady until melting starts.
    II. keep rising until melting starts.
    III. remain steady as melting proceeds.
    IV. keep rising as melting proceeds.

    A. II and III only
    B. III and IV only
    C. I, II and III only
    D. II, III and IV only

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44. A diver steps off a diving platform that is 10 m above the water. If there is no air resistance during the fall, there will be a decrease in the diver's
    A. gravitational potential energy.
    B. total mechanical energy.
    C. kinetic energy.
    D. momentum.

45. Which of the following actions would increase the electric force between two positively charged particles?
    A. Decreasing the mass of the particles
    B. Decreasing the distance between the particles
    C. Increasing the distance between the particles
    D. Increasing the mass of the particles

46. A luminous object is one that
    A. gives off dim blue-green light only in the dark.
    B. shines by reflected light only.
    C. gives out light of its own.
    D. glows only in the presence of light.

47. Which of the following units is **not** fundamental?
    A. Candela
    B. joule
    C. Kilogram
    D. Metre

48. The vacuum between the double walls of a thermos flask reduces heat loss through
    A. conduction only.
    B. radiation only.
    C. convection and conduction.
    D. conduction and radiation.

49. In photoelectric effect, the number of electrons emitted per second from a metallic surface is proportional to the
    A. work function of the metal.
    B. energy of the incident radiation.
    C. frequency of the radiation.
    D. intensity of the incident radiation.

50. When two cells of negligible internal resistance and equal e.m.f. denoted by E_1 and E_2 are connected in parallel, the combined e.m.f. E is given by
    A. $E = \dfrac{E_1}{E_2}$
    B. $E = E_1 = E_2$
    C. $\dfrac{1}{E} = \dfrac{1}{E_1} + \dfrac{1}{E_2}$
    D. $E = E_1 + E_2$

END OF PAPER

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