

2024 UTME PHYSICS

OBJECTIVE STRUCTURED QUESTIONS

1. A bifocal lens can be used to correct which type of defect? A. short sightedness B. long sightedness C. presbyopia D. astigmatism
2. A car travels 8 km due north then 5 km at 60° east of north. What is its displacement from the starting point? A. 13.21 km B. 11.36 km C. 8.32 km D. 10.44 km
3. An object is placed 10m in front of a plane mirror. If it is moved 8 m further away from the mirror, what will be the new image distance from the object? A. 8 m B. 10 m C. 18 m D. 36 m
4. The device used to measure the angle of dip is? A. Dip protractor B. Dip circle C. Compass needle D. Sextant
5. What is the final volume of a gas with an initial volume of 546 cm³ at 0 °C, if the temperature drops to -100 °C. A. 364 cm³ B. 436 cm³ C. 862 cm³ D. 346 cm³
6. Frictional force is an advantage in which of the following situations? A. stopping a car suddenly B. holding an object firmly C. Sliding down a slide D. walking on a slippery floor.
7. Which of these materials has a very large energy gap? A. Copper (Cu) B. Silicon (Si) C. Diamond (C) D. Graphite (C)
8. What is the flux density of a magnetic field whose flux is 1500 μwb and a conducting surface area of 0.5 m². A. 750 μT B. 30 μT C. 300 μT D. 3000 μT
9. A body is pulled on a smooth horizontal surface with a rope at 30° to the vertical. If the effective force pulling the body along the horizontal surface is 15N, calculate the tension in the rope. A. 17.3 N B. 20.0N C. 30.0N D. 13.0N
10. A spherical metal ball of radius 1 cm falls with a steady velocity of 2 m/s down a viscous liquid in a container. If the viscous force of the liquid is 0.02 N at room temperature, calculate the coefficient of viscosity of the liquid ($\pi = 3.142$). A. 0.021 Pa.s B. 0.053 Pa.s C. 0.010 Pa.s D. 0.002 Pa.s
11. If the same quantity of heat is supplied to substance P and Q and P has a temperature rise twice that of Q and Q has a mass that is half of the mass of P. Find the ratio of the specific heat capacity of P to that of Q. A. 1:4 B. 4:1 C. 1:2 D. 2:1
12. If a virtual image appears larger than the object and is formed on the same side as the object, the possible mirror/lens used is? A. Concave lens B. Convex lens C. Concave mirror D. Convex mirror
13. Calculate the energy stored in an inductor of inductance 10 mH when a current of 8A flows through. A. $6.4 \times 10^{-3} \text{ J}$ B. $6.4 \times 10^{-1} \text{ J}$ C. $3.2 \times 10^{-1} \text{ J}$ D. $3.2 \times 10^{-2} \text{ J}$
14. The displacement of a particle is given as $s = 2x^3 + 5x - 4$, find the equation for its velocity. A. $6x^2 + 5x$ B. $6x^2 + 5$ C. $2x^3 + 5x - 4$ D. $6x^3 + 5x - 4$
15. The volume of a gas at 25 °C is said to be doubled at A. 556 K B. 596 K C. 273 K D. 334 K
16. To prevent electric appliances from damage, all but one of these is commonly used. A. fuse B. surge protector C. overload protectors and relays D. switch
17. Pascal's law of pressure transmissibility is applicable to which of these devices? A. Hydraulic lift B. Siphon C. Hydrometer D. Hygrometer
18. How long does it take a 7.50W rated filament to convert 0.01 kg of water at 100 °C to steam? [Specific latent heat of vapour of steam = $2.20 \times 10^6 \text{ J kg}^{-1}$]. A. 60.20 min B. 29.33 min C. 48.89 min D. 52.25 min
19. For two traveling waves to form a standing waves, the waves must have the same: I. Frequency II. Wavelength III. Amplitude IV. Direction. A. I and II B. I and III C. I, II and III D. I, II, III and IV
20. If the mass of an object attached to the spring of a simple harmonic oscillator is doubled, what is the ratio of the new period to the old one? A. $\frac{1}{\sqrt{2}}$ B. $\sqrt{2}$ C. 2 D. $\frac{1}{2}$
21. A uniform solid cube material of sides 10cm has a mass of 700g. What percentage of its volume will be submerged in water? [relative density of water = 1 g cm^{-3}] A. 50% B. 60% C. 70% D. 80%
22. The energy transfer process that is mostly clearly associated with a temperature difference is A. convection B. radiation C. conduction D. convection and radiation
23. The flow of blood in human body is based on the heat transfer process known as A. heat convection B. heat conduction C. heat radiation D. heat evaporation
24. The amount of energy per unit mass that must be transferred as heat when a substance completely undergoes a phase change is described as A. heat of vapourization B. heat of fusion C. heat of sublimation D. heat of transformation
25. Which of the following statements is NOT TRUE? A. Lying on a bed of nails is more comfortable than sitting on the same bed B. an ideal fluid has internal frictional force between its adjacent layers C. when a fluid is at rest in a container, all portions of the fluid must be in static equilibrium with respect to the observe D. A change in pressure applied to an enclosed fluid is transmitted to every point of the fluid and to the walls of the container.
26. The function of a moderator in a nuclear reactor is to A. slow down high energy neutrons B. increase the chain reaction C. moderate the number of nuclei available for the chain reaction D. increase the number of fissionable nuclei.
27. Which of the following statement is correct? I. A freely suspended magnet always aligns in the North-South direction II. The magnetic lines of force due to a bar magnet cannot intersect at all III. In Fleming's left hand rule, the middle finger represents the direction of magnetic field. A. I only B. II only C. I and II only D. I, II and III only
28. The magnetic flux in a coil changes from $20 \times 10^{-1} \text{ wb}$ to $12 \times 10^{-1} \text{ wb}$ in 0.2 s. Calculate the value of the induced e.m.f in the coil. A. 0.4 V B. 0.04 V C. 4 V D. 40 V
29. A $1.60 \times 10^{-19} \text{ C}$ ion is accelerated from rest through a potential difference of 0.75kV to a speed of $8.5 \times 10^4 \text{ m/s}$. Calculate the mass of this ion. A. $1.67 \times 10^{-27} \text{ kg}$ B. $9.11 \times 10^{-31} \text{ kg}$ C. $3.32 \times 10^{-26} \text{ kg}$ D. $4.84 \times 10^{-26} \text{ kg}$
30. Which of the following circuit exhibits its maximum power dissipation? A. Pure inductive circuit B. Pure capacitive circuit C. Pure resistive circuit D. Combined capacitive and inductive circuit
31. An object is placed at 20 cm in front of a concave mirror produces a three-fold magnitude real image. Obtain the

focal length of the mirror. A. 15 cm B. 6.6 cm C. 7.5 cm D. 10 cm

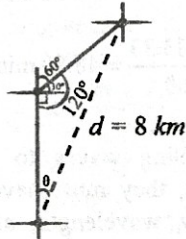
32. Which of the following is not as a consequence or application of the phenomenon of the total internal reflection? A. Brilliance of the diamond B. Working of optical fibre C. Mirage on a hot summer day D. Difference between real and apparent depth
33. A hypermetropic person with near point 0.75 m wears a spectacle of power 2.5D, the new near point is now? A. 0.26 m B. 0.75 m C. 0.86 m D. 0.17 m
34. Which of the following has the largest number of free electrons? A. Pure semiconductor B. Impure semiconductor C. Insulator D. Conductor
35. In a PN junction diode A. the current in the forward biased condition is generally very small B. the current in the reversed biased condition is generally very high. C. The current in the reverse biased condition is generally very small D. The forward biased current is very small in comparison to reverse biased current.
36. In photoelectricity, the stopping potential of a fast-moving photoelectron is I. independent of frequency of incident photon II. independent of wavelength of the incident photon III. Independent of the intensity of incident photon. Which of the statements above is/are true? A. I only B. II only C. III only D. I and II only
37. A string of mass 2500 g and length 20 m is under a tension of 2×10^2 N. If it is struck at one end and produce a disturbance, the disturbance will reach the other end in A. 1.0 s B. 1.5 s C. 2.0 s D. 3.2 s
38. A man's voice is usually different from a woman's voice mainly due to the difference in their A. pitch B. quality C. loudness D. wavelength
39. Railway lines, 25 m long, are being laid when the temperature is 15 °C. Gaps of 1.8 cm are being left between them. At which temperature will they touch each other given that its coefficient of linear expansivity is $1.2 \times 10^{-5}/^\circ\text{C}$. A. 55 °C B. 50 °C C. 75 °C D. 110 °C
40. The escape velocity of a body I. varies directly as its mass II. varies inversely as its mass III. Varies directly as the square root of its mass IV. Does not depend on its mass. Which of the above statements is true? A. I only B. II only C. III only D. IV only

2024 UTME STRUCTURED PHYSICS SOLUTION

1. C: Presbyopia

Presbyopia is the normal loss of near focusing ability of the eye that occurs with age. It is corrected by using a bio-focal lens. The lens has two prescriptions in one lens; the top part of the lens is for distance vision while the lower part is for the near vision.

2. B:



by cosine rule,
 $d^2 = 8^2 + 5^2 - 2(8 \times 5) \cos 120$
 $d^2 = 89 - 80 \cos 120$
 $d^2 = 89 + 80(0.5)$
 $d^2 = 89 + 40 = 129$
 $d = \sqrt{129} = 11.36 \text{ km}$

To find the direction

by sine rule

$$\frac{\sin \theta}{5} = \frac{\sin 120}{8}$$

$$\theta = \sin^{-1} \left[\frac{5 \sin 120}{8} \right]$$

$$\theta = \sin^{-1}(0.5413)$$

$$\theta = 32.77^\circ$$

3. D: 36 m

Initial object distance, $u = 10 \text{ m}$
 additional distance moved = 8 m
 new object distance
 $= 10 \text{ m} + 8 \text{ m} = 18 \text{ m}$
 since it is a plane mirror, the image distance is equal to the object distance. So, new image distance from the mirror is 18 m and 36 m (18 m + 18 m) from the object.

4. B: Dip circle

A dip circle is a scientific instrument used to measure the angle of dip (the angle between the earth's magnetic field and the horizontal plane). It is also known as a dip needle or inclination compass.

5. D: 346 cm³

given: $V_1 = 546 \text{ cm}^3$, $T_1 = 0^\circ\text{C} + 273 \text{ K}$,
 $T_2 = -100^\circ\text{C} + 273 = 173 \text{ K}$

using Charles law

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$V_2 = \frac{T_2}{T_1} \times V_1$$

$$V_2 = \frac{173}{273} \times 546 \text{ cm}^3$$

$$= 346 \text{ cm}^3$$

6. B: Holding an object firmly

Friction helps to keep object in place making it easier to hold on

NB: Frictional force is an advantage when it helps prevent slipping or sliding or when it provides traction. Stopping a car slowly and not suddenly. Stopping a car suddenly generates heat. Thus, frictional force is disadvantageous in this case

7. C: Diamond

Energy gap refers to the energy difference between the valence band and conduction band for a substance. A large energy gap indicates an insulator, while a small energy gap indicates a semi-conductor and a very small gap indicates a conductor.

Diamond has a very large energy gap making it an excellent electrical insulator.

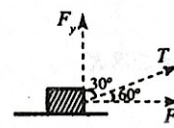
8. D:

given: flux $\Phi = 1500 \mu\text{wb}$, flux density, $\beta = ?$, Area, $A = 0.5 \text{ m}^2$.

using, $B = \frac{\Phi}{A}$

$$B = \frac{1500}{0.5} = 3000 \mu\text{T}$$

9. C: 30 N



Effective force pulling the body along the horizontal surface

$$F_x = T \cos \theta$$

$$\Rightarrow 15 = T \cos 60$$

$$T = \frac{15}{\cos 60} = \frac{15}{1/2} = 30 \text{ N}$$

10. B: 0.053 Pa.s

given: Viscous force, $F = 0.02 \text{ N}$
 $r = \text{radius of sphere} = 1 \text{ cm} = 0.01 \text{ m}$,
 $\eta = \text{coefficient of viscosity} = ?$
 $v = \text{velocity} = 2 \text{ m/s}$

By Stokes' law

$$F = 6 \pi \eta r v$$

$$\eta = \frac{F}{6 \pi r v} = \frac{0.02}{6 \times 3.142 \times 0.01 \times 2}$$

$$\eta = \frac{0.02}{0.37704} = 0.0530$$

$\eta = 0.053 \text{ Pa.s}$

Note: The coefficient of viscosity (η) of a liquid is a measure of the fluid's resistance to flow. A higher value of η indicates a more viscous liquid.

11. A:

	P	Q
q:	q_p	q_q
$\Delta\theta$:	$2\Delta\theta$	$\Delta\theta$
m:	m	m/2

$$q = c_p \Delta \theta$$

$$\text{since } q_p = q_q$$

$$(mc\Delta\theta)_p = (mc\Delta\theta)_q$$

$$m \times c_p \times 2\Delta\theta = \frac{m}{2} \times c_q \times \Delta\theta$$

$$2c_p = \frac{c_q}{2}$$

$$4c_p = c_q$$

$$\frac{c_p}{c_q} = \frac{1}{4}$$

$$c_p : c_q = 1 : 4$$

12. B: convex lens

13. C:

$$L = 10mH = 10 \times 10^{-3} H, i = 8A$$

$$\begin{aligned} \text{energy stored} &= \frac{1}{2} Li^2 \\ &= \frac{1}{2} \times 10 \times 10^{-3} \times 8^2 \\ &= 320 \times 10^{-3} J \\ &= 3.2 \times 10^{-1} J \end{aligned}$$

14. B:

$$s = 2x^3 + 5x - 4$$

$$\begin{aligned} \text{Velocity, } v &= \frac{ds}{dt} = 2(3)x^{3-1} + 5(1)x^{1-1} \\ &= 6x^2 + 5x^0 = 6x^2 + 5 \end{aligned}$$

15. B:

given:

$$T_1 = 25^\circ C + 273 = 298 K$$

$$V_1 = V$$

$$V_2 = 2V, T_2 = ?$$

Using Charle's law

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$T_2 = \frac{V_2}{V_1} \times T_1 = \frac{2V}{V} \times 298$$

16. D: Switches

Switch does not prevent damage of electrical appliances fuse: melts when excessive current flows, disconnecting power to the appliance.

- Surge protector: absorbs voltage spikes and surges, preventing damage to appliances.

- Overload protector: Disconnects power when the appliance's capacity is exceeded.

17. A: Hydraulic lift

- Hydraulic lift is a device that uses the principle of Pascal's law of pressure transmissibility to lift heavy loads or objects.

- A siphon is a device or system that uses the principle of atmospheric pressure and gravity to transfer liquids from a high container (level) to a lower one without the need for pumps or other external energy

sources.

- Hydrometer is a device used to measure the relative density of a liquid.

- Hygrometer measures the relative humidity.

18. D: 48.89 min

$$\text{given: } P = 7.50N, m = 0.01 kg$$

$$\text{Energy} = \text{power} \times \text{time} = ml_v$$

$$t = \frac{ml_v}{P} = \frac{0.01 \times 2.2 \times 10^6}{7.5}$$

$$t = 2,933.33$$

$$\text{In minutes } \frac{2,933.33}{60} = 48.89 \text{ min}$$

19. C: I, II and III

For two travelling waves to form standing waves, they must have the same frequency, wavelength, amplitude but opposite direction.

20. B: $\sqrt{2}$

For a simple harmonic oscillator,

$$\omega = 2\pi f = \frac{2\pi}{T} = \sqrt{\frac{k}{m}}$$

$$\text{thus, } \frac{2\pi}{T} = \sqrt{\frac{k}{m}}$$

$$\text{or } \frac{T}{2\pi} = \sqrt{\frac{m}{k}}$$

$$T = 2\pi \sqrt{\frac{m}{k}}$$

$$\text{i.e. } T \propto \sqrt{m}$$

$$\Rightarrow \frac{T_1}{\sqrt{m_1}} = \frac{T_2}{\sqrt{m_2}}$$

$$\frac{T_2}{T_1} = \frac{\sqrt{m_2}}{\sqrt{m_1}}$$

$$m_1 = m, m_2 = 2m$$

$$\frac{T_2}{T_1} = \sqrt{\frac{2m}{m}} = \sqrt{2}$$

21.

$$\text{given: } l = 10 \text{ cm, } \rho = 10^3 = 1000 \text{ cm}^3$$

$$\rho_{\text{solid}} = \frac{\text{Mass}}{\text{Vol.}} = \frac{700g}{1000\text{cm}^3}$$

$$= 0.7g/\text{cm}^3$$

$$\rho_{\text{water}} = 1g/\text{cm}^3$$

Note % submerged

$$= \frac{\rho_{\text{solid}}}{\rho_{\text{water}}} \times 100\%$$

$$= \frac{0.7g/\text{cm}^3}{1g/\text{cm}^3} \times 100\%$$

$$= 70\%$$

22. C: Conduction

In conduction, heat is transferred through the vibratory of the solid from a hotter region to a colder region.

23. A: Heat convection

Convection heat transfer involve the transfer of heat from one place to another

other owing to the bulk movement of the fluid (blood in this case).

24. D: heat of transformation

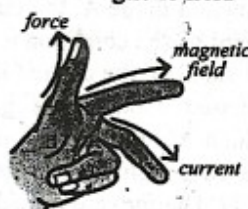
25. B: An ideal fluid has no internal friction between its layers i.e. it is non-viscous.

26. A: To slow down high energy neutrons. Generally, graphite is used as a moderator in nuclear power plant.

27. C: I and II only

In Fleming's left-hand rule, middle finger represents the direction of current flowing through the conductor. The thumb represents the direction of the magnetic force.

The fore finger represents the direction of the magnetic field



28. C: 4V

$$\text{Induced Emf} = \frac{-N\Delta Q}{\Delta t}$$

$$Q_1 = 20 \times 10^{-1} \omega b,$$

$$Q_2 = 12 \times 10^{-1} \omega b,$$

$$\Delta t = 0.2s$$

$$\begin{aligned} \text{Emf} &= \frac{-\Delta\theta}{\Delta t} \left(\text{assuming } N=1 \right) \\ &= \frac{-(12-20) \times 10^{-1}}{0.2} \\ &= \frac{8 \times 10^{-1}}{0.2} = 4V \end{aligned}$$

29. C:

$$\text{given: } q = 1.6 \times 10^{-19} C$$

$$P.d, V = 0.75 KV = 750 V$$

$$\text{Vel.} = 8.5 \times 10^4 \text{ m/s, } m = ?$$

$$\text{Using, } w = \frac{1}{2} mv^2 = qV$$

$$mv^2 = \frac{2qV}{v^2}$$

$$m = \frac{2 \times 1.6 \times 10^{-19} \times 750}{(8.5 \times 10^4)^2}$$

$$m = \frac{2400 \times 10^{-19}}{72.25 \times 10^8}$$

$$= 33.218 \times 10^{-19-8}$$

$$= 33.218 \times 10^{-27}$$

$$= 3.32 \times 10^{-26} kg$$

30. C: Pure resistive circuit.

31. A: 15 cm

$$u = 20 \text{ cm, } m = 3$$

$$m = \frac{v}{u}$$

$$v = mu,$$

$$v = 3 \times 20$$

$$v = 60 \text{ cm}$$

Using, $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$$\frac{1}{f} = \frac{1}{20} + \frac{1}{60}$$

$$\frac{1}{f} = \frac{3+1}{60}$$

$$\frac{1}{f} = \frac{4}{60}$$

$$f = \frac{60}{4} = 15\text{cm}$$

32. D: Difference between real and apparent dept.

33. C:
First, we obtain the focal length using

$$D = \frac{1}{f} = 2.5$$

with the lens formula

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

Since, the person is wearing spectacles, the object distance u is the near point without obstacle $u = 0.75\text{ m}$ and v is the new near point thus,

$$2.5 = \frac{1}{0.75} + \frac{1}{v}$$

$$2.5 - \frac{1}{0.75} = \frac{1}{v}$$

$$2.5 - 1.33 = \frac{1}{v}$$

$$\frac{1}{v} = 1.167, v = 0.86\text{m}$$

34. D: Conductor

- Conductors have large number of mobile electrons that enables them conduct electricity easily.
- Impure or extrinsic semiconductors have more free electrons than their pure or intrinsic counterpart.
- Insulator have little or no free electrons. Their electrons are strongly bound to their atoms making them poor conductors of electricity.

35. C:

The current in the reverse biased condition is generally very small in comparison to the forward-biased current.

36. C: III only

Photoelectricity is the ejection of electron from the surface of a metal when light of sufficient frequency is incident on the metal surface. The minimum potential required to stop the electron so emitted so that its kinetic energy becomes zero is called stopping potential.

From Einstein's photoelectric relation;

$$\Delta E = K.E_{\text{max}} = eV_s = hf - hf_0$$

$$= hc \left(\frac{1}{\lambda} - \frac{1}{\lambda_0} \right)$$

$$\Delta E = hf - hf_0 = eV_s = K.E_{\text{max}}$$

Where V_s is the stopping potential.

From the equation, the stopping potential depends on the frequency and wavelength of the incident radiation and independent of the intensity of the incident radiation.

37. B: 0.5s

$$\text{given: } m = 2500\text{g} = 2.5\text{ kg}$$

$$C = 20\text{m}, T = 2 \times 10^2\text{N}$$

$$\mu = \frac{m}{l} = \frac{2.5}{20} = 0.125\text{kgm}^{-1}$$

Velocity of transverse wave along the string

$$v = \sqrt{\frac{T}{\mu}}$$

$$v = \sqrt{\frac{200}{0.125}} = 40\text{ms}^{-1}$$

$$\text{also, } v = \frac{\text{distance}}{\text{time}}$$

$$\text{time} = \frac{20}{40} = 0.5\text{s}$$

38. A: Pitch

Women have shorter vocal cords which vibrate more quickly and produce a higher pitch (frequency) while men with longer vocal cords vibrate with low pitch or frequency.

39. C:

$$\text{given: } \alpha = 1.2 \times 10^{-5} / ^\circ\text{C}$$

$$c = 25\text{m}, \theta_1 = 15^\circ\text{C}$$

$$\Delta l = \alpha l_0 \Delta \theta$$

$$0.018 = 1.2 \times 10^{-5} \times 25 \times (\theta_1 - 15)$$

$$\frac{0.018}{1.2 \times 10^{-5} \times 25} = \theta_2 - 15$$

$$0.0006 \times 10^5 = \theta_2 - 15$$

$$60 = \theta_2 - 15$$

$$\theta_2 = 60 + 15$$

$$\theta_2 = 75^\circ\text{C}$$

40. D: IV only

Escape velocity is the minimum velocity required to escape the gravitational field of the earth.

$$v_{\text{escape}} = \sqrt{\frac{2GM}{R}} = \sqrt{2gR} = 11.2\text{km s}^{-1}$$

where, G = universal gravitational constant,

M = mass of the earth.

thus, v_{escape} is independent of the mass of the body.