Please read the following instructions carefully.

1. This paper is made up of 50 Multiple-Choice questions and comprises ELEVEN (11) printed pages.

2. Do not write on the question paper.

3. Answer all questions and indicate your answers on the answer sheet provided. Marks will not be deducted for wrong answers.

4. Do not take any paper, including the question paper or unused answer sheets, out of the examination hall.
Multiple-Choice Questions

Answer all questions in this section.

1. A car accelerates uniformly from 10 to 20 ms$^{-1}$ in a distance of 150m; How long after that will it reach 40 ms$^{-1}$?
   - A 40s
   - B 20s
   - C 45s
   - D 15s
   - E 30s

2. A parachuter of mass 75 kg falls towards the earth at a speed of 25 ms$^{-1}$. What is the resultant force acting on the person?
   - A 750N
   - B 450N
   - C 1,350N
   - D No net force
   - E 1,500N

3. Light travels at different speed through different materials. If it travels at speed $c_1$ in a medium of refractive index 1.2, what is its speed in a medium of refractive index 1.6?
   - A $1.3c_1$
   - B $0.67c_1$
   - C $2c_1$
   - D $1.7c_1$
   - E $0.55c_1$

4. Speed of sound in air is 340ms$^{-1}$. A shot is fired and the echo is heard 2 s after the shot was fired. How far is the reflecting surface?
   - A 340m
   - B 680m
   - C 170m
   - D 85m
   - E 34m

5. The oscillation of a pendulum is simple harmonic when the amplitude is small compared to its length. This is because:
   - A a long pendulum loses less energy.
   - B the restoring force is proportional to displacement at small angles.
   - C friction of the pivot is smaller when the pendulum is long.
   - D a long pendulum is more massive.
   - E it has a higher length to mass ratio.
6. A coil of wire stores energy in the form of
   A charge .
   B potential difference .
   C magnetic field .
   D A and B .
   E A and C .

7. The angular frequency of a wave is $2000\pi$ and its phase velocity is $320\text{ms}^{-1}$. Its period is
   A $10^{-3}\text{s}$.
   B $5\times10^{-4}\text{s}$.
   C $10\text{ ms}$.
   D $100\mu\text{s}$.
   E $0.05\text{s}$.

8. A motor has both resistance and inductance. A motor rated at 1 hp input operating at 240V draws 4 A of current because
   A power is lost due to resistance .
   B magnetic saturation robs power .
   C inductance does not consume power .
   D friction in the bearings of the motor .
   E A and B .

9. A sinusoidal alternating current is fullwave rectified. The rectified current will produce in the same load
   A the same power .
   B 0.71 times the power .
   C 1.41 times the power .
   D half the power .
   E twice the power .

10. Capacitance is measured in
    A Farads .
    B Henrys .
    C Ohms .
    D Pascal .
    E Watts .
11. Fluorescent lamps use phosphors to produce visible light from UV light. This is done by absorbing the UV light and then re-radiating it using a different wavelength. This is a

A one way process.
B reversible process.
C process that produces continuous spectrum.
D process that produces a single wavelength only.
E process that is very inefficient.

12. The property of a transparent material that makes it useful as material for a lens is

A refraction.
B diffraction.
C polarization.
D dispersion.
E absorption.

13. Which of the properties listed below determines the energy of a photon

A wavelength.
B intensity of the beam.
C speed of the photon.
D polarization.
E frequency.

14. The conservation of linear momentum in a collision does not apply if

A sound is generated during impact.
B the collision is inelastic.
C frictional forces are present.
D the objects do not collide head-on.
E The collision is partially elastic only.

15. A simple glass lens do not focus the image of an object correctly under white light because

A the lens absorbs light.
B the glass has some colouration due to impurities.
C the surface of the lens reflect some light.
D a glass prism splits sunlight into different colours.
E glass absorbs UV light.
16. When measured with a digital multimeter, the potential difference of a dry cell is 1.6V. When it was used in a 2 cell flashlight with a lamp current of 0.75A, the lamp was found to be working at 2.4V. This is due to internal resistance. The internal resistance of a cell is

A 0.533Ω.
B 1.07Ω.
C 3.20Ω.
D 1.10Ω.
E 0.107Ω.

17. Heat is used to change a liquid to its gaseous state at the same temperature as the liquid. This is because of the property of the liquid called

A heat capacity.
B latern heat.
C specific heat capacity.
D conductivity.
E boiling point.

18. The shadow cast by an object on a wall by the light from a point source of light at a smaller distance from the object compared to one with the light source placed further away from the object has a sharpness of edge that is

A reduced.
B the same.
C increased.
D the same at first and then reduces.
E the same at first and then increases.

19. Two weights of mass 10kg are hung at two ends of a rope that is passed over a frictionless pulley fixed on the ceiling. The tension in the rope is

A 98N.
B 196N.
C 49N.
D 147N.
E 73.5N.

20. Two metal plates carrying charge Q is separated by a distance d. The capacitance of the resultant charged capacitor is then decreased by moving the plates. The energy stored in the capacitor

A stays the same.
B increases.
C decreases.
D stays the same if the plates are moved parallel to each other.
E decreases if the plates are moved parallel to each other.
21. The velocity of a car which is decelerating uniformly changes from 30ms\(^{-1}\) to 15ms\(^{-1}\) in 75m. After what further distance will it come to rest?
A 25m
B 37.5m
C 50m
D 75m
E 100m

22. Which one of the following pairs of forces is not valid example of action and reaction to which Newton’s third Law of Motion applies?
A the centripetal force holding a satellite in orbit round the Earth and the weight of the satellite
B the forces of repulsion experienced by each other of two parallel wires carrying currents in opposite direction
C the forces of attraction felt by each of two gas molecules passing near to each other
D the forces of attraction between an electron and a proton in a hydrogen atom
E the forces of repulsion between an atom in the surface of a table and an atom in the surface of a book resting on the table.

23. A helicopter of mass 3.0\times10^3\text{kg} rises vertically with a constant speed of 25ms\(^{-1}\). Taking the acceleration of free fall as 10ms\(^{-1}\), what resultant force acts on the helicopter?
A Zero
B 3.0\times10^4\text{N} downwards
C 4.5\times10^4\text{N} upwards
D 7.5\times10^4\text{N} upwards
E 10.5\times10^4\text{N} upwards

24. Which one of the following is not measured in units of energy?
A couple \times angle turned through
B moment of inertia \times (angular velocity)^2
C force \times distance
D impulse \times time
E mass \times acceleration \times distance

25. A car of mass \(m\) moving at a constant speed \(v\) passes over a humpback bridge of radius of curvature \(r\). Given that the car remains in contact with the road, what is the net force \(R\) exerted by the car on the road when it is at the top of the bridge?
A \(R = mg + \frac{mv^2}{r}\)
B \(R = \frac{mv^2}{r}\)
C \(R = mg - \frac{mv^2}{r}\)
D \(R = mg\)
E \(R = \frac{mv^2}{r - mg}\)
26. Monochromatic light of wavelength $\lambda_1$ traveling in a medium of $n_1$ enters a denser medium of refractive index $n_2$. The wavelength in the second medium is
A $\lambda_1 (n_1/n_2)$
B $\lambda_1 (n_2/n_1)$
C $\lambda_1$
D $\lambda_1 (n_2 - n_1)/n_1$
E $\lambda_1 (n_2 - n_1)/n_2$

27. A sound wave of frequency 400Hz is traveling in air at a speed of 320ms$^{-1}$. What is the difference in phase between two points on the wave 0.2m apart in the direction of travel?
A $\pi/4$ rad
B $\pi/2$ rad
C $2\pi/5$ rad
D $4\pi/5$ rad
E $8\pi/5$ rad

28. An opaque object 10cm wide casts a shadow when placed in a beam of light but has little effect on a beam of sound emitted by a small source of frequency 500 Hz. This is because
A sound is a pressure wave whereas light is an electromagnetic wave
B sound travels much more slowly than light
C sound waves are longitudinal whereas light waves are transverse.
D sound waves have a much longer wavelength than light waves
E the power per unit area in a beam of sound is much lower than that in a beam of light

29. A solid $X$ is in thermal equilibrium with a solid $Y$, which is at the same temperature as a third solid $Z$. The three bodies are of different materials and masses. Which one of the following statements is certainly correct?
A $X$ and $Y$ have the same heat capacity
B $Y$ and $Z$ have the same internal energy
C There is no net transfer of energy if $X$ is placed in thermal contact with $Z$
D It is not necessary that $Y$ should be in thermal equilibrium with $Z$
E It is not necessary that $X$ should be at the same temperature as $Y$

30. A fixed mass of gas at constant pressure occupies a volume $V$. The gas undergoes a rise in temperature so that the root mean square velocity of its molecules is doubled. The new volume will be
A $V/2$
B $V/\sqrt{2}$
C $V\sqrt{2}$
D $2V$
E $4V$
31. The densities of water and steam are $1.0 \times 10^3 \text{kgm}^{-3}$ and $6.1 \times 10^{-1} \text{kgm}^{-3}$ respectively. What is the ratio average separation of steam molecules/average separation of water molecules?

A 12
B 40
C 250
D 1600
E 61000

32. When electricity conduction is compared with heat conduction, the electrical analogue of rate of flow of heat is

A drift velocity of the charge carriers
B power dissipated
C electrical conductivity
D electric current
E potential gradient

33. The resistance of a semiconductor decreases rapidly with increasing temperature. The main factor contributing to this effect is the rapid increase, with increasing temperature of

A the speed of the random motion of the free charge carriers
B the concentration of the free charge carriers
C the drift velocity of the free charge carriers
D the frequency of vibration of the atoms of the semiconductor
E the amplitude of vibration of the atoms of the semiconductor

34. An alternating potential difference is connected across a pure resistor and the frequency of the supply is varied keeping the r.m.s voltage constant. The mean rate of production of heat in the resistor is

A proportional to $(\text{frequency})^2$
B proportional to frequency
C proportional to $(\text{frequency})^{1/2}$
D inversely proportional to frequency
E independent of frequency

35. Double-ionized oxygen atoms ($\text{O}^{2-}$) and singly-ionized lithium atoms ($\text{Li}^+$) are traveling with the same speed, perpendicular to a magnetic field which causes them to move in circular orbits. The relative atomic masses of oxygen and lithium are 16 and 7 respectively. What is the ratio radius of $\text{O}^{2-}$ orbit/radius of $\text{Li}^+$ orbit?

A 16/7
B 8/7
C 7/8
D 7/16
E 7/32
36. Photon is the name given to
A an electron emitted from a metal surface by the action of light
B a unit of energy
C a positive charged atomic particle
D an electron emitted from a metal surface by the action of heat
E a quantum of electro-magnetic radiation

37. Which one of the following statements referring to photoelectric emission is always true?
A No emission of electrons occurs for very low intensity illumination
B For a given metal there is a minimum frequency of radiation below which no emission occurs.
C The velocity of the emitted electrons is proportional to the intensity of the incident radiation.
D The number of electrons emitted per second is independent of the intensity of the incident radiation.
E The number of electrons emitted per second is proportional to the frequency of the incident radiation.

38. The intensity of a beam of monochromatic light is doubled. Which one of the following represents the corresponding change, if any, in the momentum of each photon of the radiation?
A increased fourfold
B doubled
C the same
D halved
E reduced fourfold

39. Transition between three energy levels in a particular atom gives rise to three spectral lines of wavelengths, in increasing magnitudes, \( \lambda_1 \), \( \lambda_2 \) and \( \lambda_3 \). Which one of the following equations correctly relates \( \lambda_1 \), \( \lambda_2 \) and \( \lambda_3 \)?
A \( \frac{1}{\lambda_1} = \frac{1}{\lambda_2} - \frac{1}{\lambda_3} \)
B \( \frac{1}{\lambda_1} = \frac{1}{\lambda_2} - \frac{1}{\lambda_3} \)
C \( \frac{1}{\lambda_1} = \frac{1}{\lambda_2} + \frac{1}{\lambda_3} \)
D \( \frac{1}{\lambda_1} = \frac{1}{\lambda_2} + \frac{1}{\lambda_3} \)
E \( \frac{1}{\lambda_1} = \frac{1}{\lambda_2} + \frac{1}{\lambda_3} \)

40. When \( ^{239}_{92}U \) is bombarded with slow neutrons, it is transformed, absorbing a single neutron and subsequently emitting two \( \beta^- \) particles. The resulting nuclide is
A \( ^{240}_{93}Np \)
B \( ^{241}_{91}Pa \)
C \( ^{239}_{94}Pu \)
D \( ^{239}_{90}Th \)
E \( ^{233}_{88}Ra \)
41. The mass of an isotope of uranium $^{238}_{92}U$ is 238.05 g mol$^{-1}$. Its density is 19.1 g cm$^{-3}$ at room temperature. Which of the following is closest to the number of $^{238}_{92}U$ atoms in 1 cm$^3$ of this isotope?

A $2.53 \times 10^{21}$
B $3.29 \times 10^{22}$
C $4.83 \times 10^{22}$
D $6.02 \times 10^{23}$
E $7.51 \times 10^{24}$

42. An isotope of plutonium $^{239}_{94}Pu$ decays by alpha emission. Which of the following is the decay product?

A $^{243}_{98}Cm$
B $^{235}_{94}Pu$
C $^{239}_{93}Np$
D $^{235}_{92}U$
E $^{234}_{90}Th$

43. A compact disc of diameter 120 mm is spinning at a speed of 500 revolutions per minute. Which of the following is closest to the linear speed of the outer edge of the disc?

A $0.50$ m s$^{-1}$
B $1.0$ m s$^{-1}$
C $1.6$ m s$^{-1}$
D $3.1$ m s$^{-1}$
E $60$ m s$^{-1}$

44. A steel wire is stretched and clamped between two fixed points that are spaced 1.0 m apart. Which of the following is closest to the fundamental wavelength that can exist on this wire?

A $0.25$ m
B $0.50$ m
C $1.0$ m
D $2.0$ m
E $4.0$ m

45. A thin converging lens of focal length 20 cm is used to shape light from a lamp filament into a parallel beam. Which of the following is closest to the required distance between the lamp filament and the lens?

A $5.0$ cm
B $10$ cm
C $20$ cm
D $40$ cm
E $80$ cm
46. A metallic sphere of radius 1.0 cm is charged with 1.0x10^9 electrons in air. Which of the following is closest to the electric potential difference between the surface of this sphere and a point far away? [The electric potential of a charged metallic sphere varies with distance $r$ from the centre of the sphere according to $V = \frac{1}{4\pi \varepsilon_0} \frac{q}{r}$ for $r \geq r_o$, where $r_o$ is the radius of the sphere.]

A  70 V  
B  -70 V  
C  140 V  
D  -140 V  
E  8.99x10^{20} V

47. Which of the following is closest to the wavelength of a free moving electron of energy 1.0 eV?

A  1.2 nm  
B  15 nm  
C  50 nm  
D  350 nm  
E  1240 nm

48. Which of the following is most suitable to measure the temperature of red hot molten steel?

A  bimetallic strip thermometer  
B  thermocouple  
C  optical pyrometer  
D  mercury-in-glass thermometer  
E  silicon diode thermometer

49. Which of the following is closest to the mean distance between air molecules at room temperature and pressure (298 K and 101325 Pa)? Assume air is made of 79% N₂ and 21% O₂ by moles.

A  0.4 nm  
B  4 nm  
C  40 nm  
D  400 nm  
E  4 µm

50. The linear thermal expansion coefficient of invar is 1.3 x 10^{-6} K^{-1}. Which of the following is closest to the change in length of a 10-cm-long invar rod subjected to a change in temperature of +100ºC?

A  +0.13 µm  
B  +1.3 µm  
C  +13 µm  
D  +130 µm  
E  +1.3 mm

END OF PAPER