

CANDIDATE NAME	CT GROUP	21S
CENTRE NUMBER	INDEX NUMBER	

PHYSICS

Paper 1 Multiple Choice

9749/01 20 September 2022 60 minutes

Additional Materials: Optical Mark Sheet

INSTRUCTIONS TO CANDIDATES

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, CT, NRIC or FIN number on the optical mark sheet (OMS). Shade your NRIC or FIN in the spaces provided.

There are **thirty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** and **D**.

Choose the one you consider correct and record your choice in soft pencil on the separate OMS.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

Data speed of light in free space, $c = 3.00 \times 10^8 \,\mathrm{m \, s^{-1}}$ permeability of free space, $\mu_{\rm o} = 4\pi \times 10^{-7} \,{\rm H \, m^{-1}}$ permittivity of free space, $\varepsilon_o = 8.85 \times 10^{-12} \text{ Fm}^{-1}$ \approx (1/(36 π)) × 10⁻⁹ F m⁻¹ elementary charge, $e = 1.60 \times 10^{-19} C$ the Planck constant, $h = 6.63 \times 10^{-34} \,\mathrm{Js}$ unified atomic mass constant, $u = 1.66 \times 10^{-27} \text{ kg}$ rest mass of electron, $m_{\rm e} = 9.11 \times 10^{-31} \, \rm kg$ rest mass of proton, $m_{\rm p} = 1.67 \times 10^{-27} \, \rm kg$ molar gas constant, $R = 8.31 \,\mathrm{J \, K^{-1} \, mol^{-1}}$ the Avogadro constant, $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$ the Boltzmann constant, $k = 1.38 \times 10^{-23} \text{ J K}^{-1}$ gravitational constant, $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$ acceleration of free fall, $g = 9.81 \,\mathrm{m \, s}^{-2}$

Formulae	9
uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on / by a gas	$W = p \Delta V$
hydrostatic pressure	$p = \rho g h$
gravitational potential	$\phi = -\frac{Gm}{r}$
temperature	, 7/K = 7/ °C + 273.15
pressure of an ideal gas	$P = \frac{1}{3} \frac{Nm}{V} < c^2 >$
mean kinetic energy of a molecule of an ideal gas	$E=\frac{3}{2}kT$
displacement of particle in s.h.m.	$x = x_0 \sin \omega t$
velocity of particle in s.h.m.	$v = v_o \cos \omega t$ $= \pm \omega \sqrt{(x_o^2 - x^2)}$
electric current	I = Anvq
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \dots$
electric potential	$V = \frac{Q}{4\pi\epsilon_{a}r}$
alternating current / voltage	$x = x_0 \sin \omega t$
magnetic flux density due to a long straight wire	$B = \frac{\mu_o I}{2\pi d}$
magnetic flux density due to a flat circular coil	$B = \frac{\mu_o NI}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_0 n I$
radioactive decay	$x = x_o \exp\left(-\lambda t\right)$
decay constant	$\lambda = \frac{\ln 2}{\frac{t_1}{\frac{1}{2}}}$

- 1 Which of the following is **not** a reasonable estimate?
 - A The diameter of a strand of human hair is 80 µm
 - **B** The volume of an apple is 200 cm³
 - **C** The weight of a sheet of A4 paper on Earth is 50 mN
 - **D** The frequency of light from a green laser is 550 GHz

2 A quantity *x* was measured multiple times. The number *N* of measurements giving a value *x* is plotted against *x*. The true value of the quantity is x_0 .

Which of the following graphs best represents accurate measurements with poor precision?



3 The velocity – time graph for a train starting at one station and stopping at the next station is shown.



Another train has half of the initial acceleration but the same maximum speed and the same final deceleration.

Which velocity-time graph, on the same scale, shows the motion of this train between the same two stations?



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- 5
- 4 Two objects, A and B, are connected via a light string that runs over a smooth pulley.

Their masses are m_A and m_B respectively.

The diagram shows A moving up with velocity v_A and B moving down with velocity v_B .

Which statement is incorrect?

- **A** If $m_A = m_B$, v_A and v_B are of the same magnitude.
- **B** If $m_A = m_B$, v_A and v_B can only be zero.
- **C** m_A can be larger than m_B .
- **D** m_A can be smaller than $m_{B.}$
- 5 A bowling ball undergoes head-on elastic collision with a stationary bowling pin. The bowling ball's mass is 5 times that of the pin. Given that the pin's speed immediately after the collision is 3.33 m s⁻¹, what is the speed of the bowling ball just before the collision?
 - **A** 1.33 m s⁻¹ **B** 2.00 m s⁻¹ **C** 3.33 m s⁻¹ **D** 4.00 m s⁻¹
- 6 A thin meter rule is pivoted at its centre. Equal and opposite forces of magnitude 5.0 N are applied to the ends of the ruler, creating a couple as shown.



What is the magnitude of the torque of the couple on the ruler when it is at the position shown?

A 1.6 N m **B** 3.2 N m **C** 3.8 N m **D** 5.0 N m



7 A uniform rectangular metal sheet of length 20 cm and weight 10 N is to be suspended from a hook by a light cord XYZ, as shown below.



The material used for the cord can support a maximum tension of 20 N before breaking.

Determine the minimum length of cord that is required.

A 21 cm **B** 23 cm **C** 40 cm **D** 80 cm

8 A constant force F is applied to a stationary object of mass m on a frictionless surface. The object accelerates uniformly to reach a velocity v in time t covering a distance s during this time.

Which of the following is the correct expression for the kinetic energy of the object at time t?

Α	Fv	В	Fvt
С	Fs	D	Fst

9 A part in an engine is rotating in a circle of radius 8.0 cm at 3000 revolutions per minute. What is its centripetal acceleration?

A 25 m s^{-2} **B** 7900 m s^{-2} **C** $3.1 \text{ x} 10^4 \text{ m s}^{-2}$ **D** $7.2 \text{ x} 10^7 \text{ m s}^{-2}$

- **10** Two sites are being considered for a rocket launch. Site A is at the equator while site B is nearer to the North Pole. Taking the Earth to be a uniform sphere, which of the following statements is true?
 - A The escape speed for both sites are the same as gravitational potential at both sites are the same.
 - **B** The escape speed for site A is higher as gravitational potential at site A is larger.
 - **C** The escape speed for site A is lower as gravitational potential at site A is lower.
 - **D** The escape speed is independent of the gravitational potential.

11 A satellite of mass *m* is in a circular orbit around a planet of mass *M* and radius *R*. The satellite is traveling at a constant speed *v* at a height of *H* above the surface of the planet.

What is the total energy of the satellite?

$$\begin{array}{c} \mathbf{A} & \frac{1}{2}mv^2 - \frac{GMm}{R} \\ \mathbf{C} & \frac{1}{2}mv^2 + \frac{GMm}{R} \end{array} \end{array} \qquad \begin{array}{c} \mathbf{B} & \frac{1}{2}mv^2 - \frac{GMm}{R+H} \\ \mathbf{D} & \frac{1}{2}mv^2 + \frac{GMm}{R+H} \end{array}$$

Equal amount of an ideal gas was housed separately in containers A and B.The volume of B is larger than that of A.

Gases in both containers were maintained at a common temperature for both containers. Which statement best describe the gases inside the two containers.

- **A** The average microscopic kinetic energy of A is larger than that of B.
- **B** The gas pressure of B is larger than that of A.
- **C** The root-mean-square speed of both gases are not the same.
- D The gas density of A is larger than that of B
- 13 An ideal gas is made to run a circular cyclic process as shown.



What is the net heat transfer for this process?

Α	0 J	В	3 J into gas	С	3 J out of gas	D	6 J out of gas
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14 Figure (a) below shows the variation with frequency f of the amplitude x_0 of the forced oscillation of a system. This system is then subjected to a periodic driving force F as shown in Figure (b).



What is the frequency that the system will oscillate at?

A 0.33 Hz B 0.50 Hz C 2.0 Hz D	3.0 Hz
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15 Three sheets of polaroids P, Q and R are arranged as shown below. Polariod Q and R's direction of polarization is 30° and 60° relative to that of polaroid P.



A beam of light passes through all three polariods. After passing through polaroid P, the transmitted beam has an intensity of *I*.

What is the intensity of the beam after passing through R?

A 0.19*I* **B** 0.43*I* **C** 0.56*I* **D** 0.75*I*

16 A point source emits energy in the form of waves such that a detector of cross-sectional area A at a distance of x from the point source receives power P. A second detector of cross-sectional area 2A, is placed at another position such that its distance is 0.5x from the same point source.

What is the power received by the second detector?



17 Two monochromatic light sources of wavelength λ are separated by a fixed distance. Light from the sources passes through a single slit of slit width *a* at a distance of *D*. The image of the light sources is projected on a screen a distance of *L* from the single slit.



One is just able to distinguish that there are two light sources from the image captured on the screen.

For the image captured on screen, which of the following changes will **not** make it easier to distinguish that there are two light sources?

- **A** λ is reduced.
- **B** *D* is reduced.
- **C** *a* is increased.
- **D** *L* is increased.

18 The image below (which is to scale) is formed by shining a monochromatic laser light perpendicularly through a fine nylon mesh consisting of very close vertical and horizontal threads. The vertical threads are equally spaced such that the distance between each thread is constant. The horizontal threads are also equally spaced.



Which statement about the spacing between the vertical threads and horizontal threads is true?

- **A** The vertical and horizontal spacing are the same.
- **B** The vertical spacing is smaller than the horizontal spacing.
- **C** The vertical spacing is greater than the horizontal spacing.
- **D** There is insufficient information to determine the relative spacing between the vertical and horizontal threads.
- **19** W, X and Y are three points on the rim of a circle with centre O.



A point charge -q is fixed at W and another point charge +q is placed originally at Y.

When the positive charge +q at Y is moved to position X, which of the following statements is correct?

- **A** The electrical force between the two charges decreases.
- **B** The electric field strength at O increases.
- **C** The electric potential energy of the system decreases.
- **D** The electric potential at O increases.

20 The figure below shows two arrangements of electric field lines drawn to the same scale.



P and Q are points in the electric fields and have equal separations in both arrangements. The electric field strength and the potential at P is the same in both arrangements as well.

Which of the following graph shows the possible variation with distance x along the line PQ of the potential V?







С





21 Two bulbs are connected in series to a 15 V power supply. Bulb X is rated 10 V, 20 W and Bulb Y is rated 5 V, 2 W.



Which of the following best describes the power output of the bulbs when the switch is closed?

	power output of bulb X	power output of bulb Y
Α	20 W	2 W
В	greater than 20 W	smaller than 2 W
С	smaller than 20 W	greater than 2 W
D	smaller than 20 W	smaller than 2 W

22 Several identical metal blocks are made into wires of different lengths. Each block is melted to form a single wire with uniform cross-sectional area.

Which graph shows the variation with its length l of the resistance R of the wires?







23 Eight identical resistors, each of resistance *R*, are connected in a network as shown below.



What is the effective resistance between the terminals P and Q?



24 Four parallel straight wires carrying equal currents pass through four corners of a square PQRS as shown below. The currents in wires P and Q are directed out of the page and the currents in wires R and S are directed into the page.

Which one of the options gives the direction of the resultant magnetic field at O?



25 Two coils X and Y are arranged as shown. Coil X is connected to a current supply and coil Y is connected to a voltmeter.



Which of the following will not produce a reading in the voltmeter?

- **A** Increasing quickly the direct current supply to coil X.
- **B** Decreasing slowly the direct current supply to coil X.
- **C** Using a low alternating current supply to coil X.
- **D** Using a high direct current supply to coil X.
- 26 The figure below shows a region of uniform magnetic field directed out of the page. Outside the region, the magnetic field is zero. Four circular copper loops move with velocity v as indicated. Which of the loop/s would experience a magnetic force directed *upwards* at the instant shown?



27 The figure below shows an a.c. supply connected to resistors and diodes.



Which of the following graphs represents the variation of current with time through XY of the circuit?



28 In x-ray production, electrons are accelerated through a high voltage *V* and then decelerated when they strike a metal target. The x-ray spectrum is shown below.



- **A** 12 000 **B** 25 000 **C** 18 000 **D** 62 000
- **29** When a nucleus of uranium-235 absorbs a neutron in a nuclear reactor, it undergoes fission to form various products and releases further neutrons.

In one nuclear reaction involving the fission of uranium-235, barium-144 and another element, Z, are the products. Two neutrons are also released when these products are formed. The reaction is shown in the equation.

$$^{235}_{92}U + n \rightarrow ^{144}_{56}Ba + Z + 2n$$

How many neutrons are there in the nucleus of Z?

A 53 **B** 54 **C** 90 **D** 91

30 The ratio ¹⁴C :¹²C of living material has a constant value during life but the ratio decreases after death because the ¹⁴C is not replaced. The half-life of ¹⁴C is 5600 years.

The ¹⁴C content of a 5 g sample of living wood has a radioactive count rate of about 100 per minute. If the count rate of a 10 g sample of ancient wood is 50 per minute, the age of the sample is about

A 1400 years. B 2800 years. C 5600 years. D 11200 years.

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