HWA CHONG INSTITUTION
JC2 Preliminary Examination
Higher 2

CANDIDATE NAME		CT GROUP	16S
CENTRE NUMBER		INDEX NUMBER	

PHYSICS **9749/01**

Paper 1 Multiple Choice **21 September 2017**

1 hour

Additional Materials: Optical Mark Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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 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.

This document consists of 14 printed pages.

Data

speed of light in free space, $c = 3.00 \times 10^{8}$ m s^{-1}

permeability of free space, $\mu_o = 4\pi \times 10^{-7}$ H m^{-1}

permittivity of free space, $\varepsilon_o = 8.85 \times 10^{-12}$ F m^{-1}
$\approx (1/(36\pi)) \times 10^{-9}$ F m^{-1}

elementary charge, $e = 1.60 \times 10^{-19}$ C

the Planck constant, $h = 6.63 \times 10^{-34}$ J s

unified atomic mass constant, $u = 1.66 \times 10^{-27}$ kg

rest mass of electron, $m_e = 9.11 \times 10^{-31}$ kg

rest mass of proton, $m_p = 1.67 \times 10^{-27}$ kg

molar gas constant, $R = 8.31$ J K^{-1} mol^{-1}

the Avogadro constant, $N_A = 6.02 \times 10^{23}$ mol^{-1}

the Boltzmann constant, $k = 1.38 \times 10^{-23}$ J K^{-1}

gravitational constant, $G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}

acceleration of free fall, $g = 9.81$ m s^{-2}

Formulae

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 $p = \rho gh$

gravitational potential, $\phi = -\frac{Gm}{r}$

temperature $T/K = T/°C + 273.15$

pressure of an ideal gas $P = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$

mean kinetic energy of a molecule of an ideal gas
$E = \frac{3}{2}kT$

displacement of particle in s.h.m., $x = x_o \sin \omega t$

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, $1/R = 1/R_1 + 1/R_2 + \ldots$

electric potential, $V = \frac{Q}{4\pi\varepsilon_o r}$

alternating current / voltage, $x = x_o \sin \omega t$

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
$B = \mu_o nI$

radioactive decay, $x = x_o \exp(-\lambda t)$

decay constant, $\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

1 Which of the following is equivalent to the quantity, 37.86×10^{-4} MJ cm^{-4}?

A 37.86×10^{-18} J m^{-4}

B 37.86 μJ m^{-4}

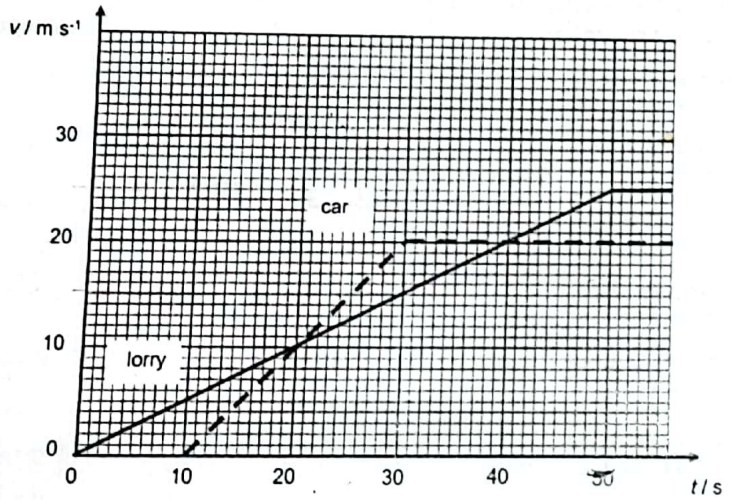
C 378.6 TJ m^{-4}

D 378.6 GJ m^{-4}

2 Which of the following is the best estimate of the population density (population per unit area) in Singapore?

A 10^{0} km^{-2} B 10^{2} km^{-2} C 10^{4} km^{-2} D 10^{6} km^{-2}

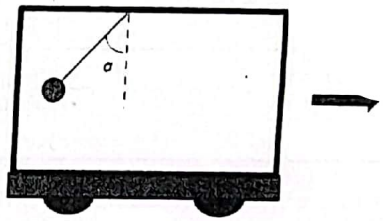
3 The variation with time t of the speed v of a lorry after leaving a petrol station is as shown in the graph below. A car leaves the petrol station 10.0 s later and its speed-time graph is also shown.



At which of the following times would the distance between the lorry and car be the least?

A 20.0 s B 30.0 s C 40.0 s D 50.0 s

4 A mass m hangs at the end of a rope which is attached to a support fixed on a trolley moving to the right with a speed v on a horizontal track, as shown. The angle, α, is the angle the rope makes with the vertical.



Which of the following statements is **false**?

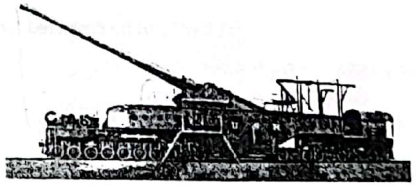
A The angle α is zero when the trolley moves with a uniform speed.

B When the trolley moves with a constant acceleration a, the magnitude of angle α is only determined by a and g.

C The tension T in the rope is larger when the trolley moves with a uniform speed than when it moves with a constant acceleration.

D The ball swings to the right when the trolley decelerates.

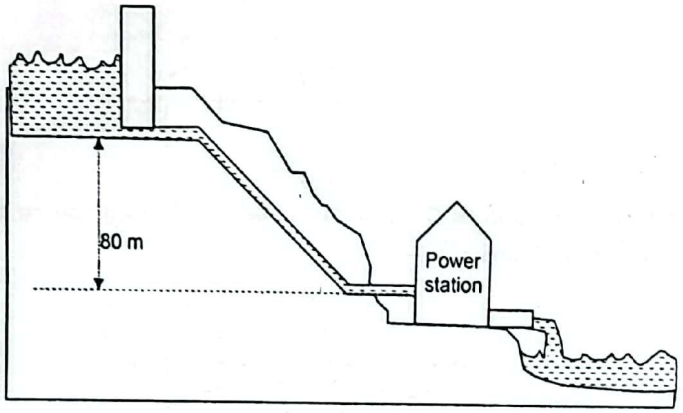
5 A 70 000 kg railway gun sitting on the railway platform in contact with the Earth is



It fires a 500 kg artillery shell at an angle of 45° and with a muzzle velocity of 200 m s^{-1}. What is the magnitude of the recoil velocity of the gun?

A 0.5 m s^{-1} B 1.0 m s^{-1} C 1.4 m s^{-1} D 2.8 m s^{-1}

6 A hydroelectric power station is shown in the figure below.



Water is supplied from a reservoir which is 80 m above the power station. The water passes through its turbines at a rate of 6.0 $m^3 s^{-1}$.

Assume that the density of water is 1000 kg m^{-3}.

If the efficiency of the power station is 60%, the electrical power output is

A 0.29 MW B 1.9 MW C 2.8 MW D 4.7 MW

7 The engine of a boat delivers 30.0 kW to the propeller while the boat is moving at a constant speed of 15.0 m s^{-1}. The total drag on the boat is proportional to the square of the speed of the boat. If the boat is being towed at 5.0 m s^{-1} after its engine has broken down, the average tension in the towline will be

A 44.4 N B 220 N C 2000 N D 3330 N

8 A light string can bear up to 3.7 kg of mass. A stone of mass 500 g is tied at its end and revolved in vertical circular path of radius 4.00 m. Taking g = 10 m s^{-2}, the maximum angular velocity of the stone is

A 3.0 rad s^{-1} B 4.0 rad s^{-1} C 5.0 rad s^{-1} D 6.0 rad s^{-1}

9 Given that the mass of Earth is M_E, the radius of Earth is R_E, the mass of Mars is M_M and the radius of Mars is R_M, the ratio of the escape speed on the surface of the Earth to the escape speed on the surface of Mars is

A $\sqrt{\frac{M_E}{M_M}\frac{R_E}{R_M}}$ B $\sqrt{\frac{M_E}{M_M}\frac{R_M}{R_E}}$ C $\sqrt{\frac{M_M}{M_E}\frac{R_E}{R_M}}$ D $\sqrt{\frac{M_M}{M_E}\frac{R_M}{R_E}}$

10 The radius of planet X is twice the radius of planet Y and both planets have the same density. The ratio of the acceleration due to gravity at the surface of X to that at the surface of Y is

A 1 : 4 B 1 : 2 C 2 : 1 D 4 : 1

11 A 2.0 kg chunk of ice at -20 °C is placed in 4.0 kg of water at an initial temperature. Assuming that there is no heat loss to the surrounding, what is the initial temperature of the water that will allow all the ice to just melt?

Specific heat capacity of water = 4200 J kg^{-1} K^{-1}
Specific heat capacity of ice = 2100 J kg^{-1} K^{-1}
Specific latent heat of fusion = 3.35 × 10^5 J kg^{-1}

A 20 °C B 40 °C C 45 °C D 90 °C

12 The density of a sample of helium gas at the pressure of 100 kPa is 0.178 kg m^{-3}. The root-mean-square speed of the helium molecules is

A 41 m s^{-1} B 1300 m s^{-1} C 561 km s^{-1} D 1685 km s^{-1}

13 A mole of a monatomic ideal gas is contained in a cylinder with a movable piston. The temperature of the gas is 200 K and the volume of the gas is 25 x 10^{-3} m^3.

The gas now expands at constant pressure such that the volume of the cylinder increases by 75 x 10^{-3} m^3. The change in internal energy of the gas is

A 7500 J B -7500 J C 10000 J D -10000 J

14 The first law of thermodynamics may be expressed as

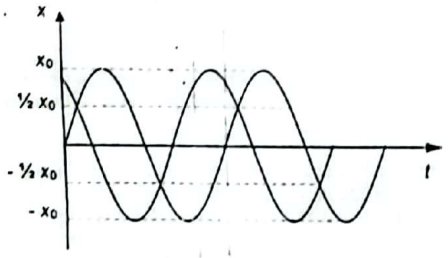
$$\Delta U = q + w$$

where ΔU is the increase in internal energy of the system,
q is the thermal energy supplied to the system,
w is the work done on the system.

Some liquid at its freezing point contracts as it turns to a solid.
What are the changes in ΔU, q and w as the liquid freezes?

	ΔU	q	w
A	negative	negative	positive
B	negative	zero	positive
C	positive	zero	negative
D	zero	negative	positive

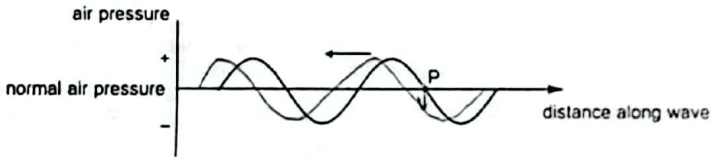
15 Two identical vertical spring mass systems hung at the same height execute simple harmonic motion of the same amplitude and frequency. The graph below shows the variation of the displacements of the masses with time. The masses pass one another at half the amplitude when they are going in opposite directions.



The phase difference between them is

A 90° B 120° C 135° D 150°

16 The graph below shows the variation of air pressure with distance along a wave at one given time. The arrow indicates the direction of travel of the wave.



The air pressure at point P is

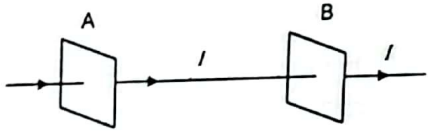
A increasing

B decreasing

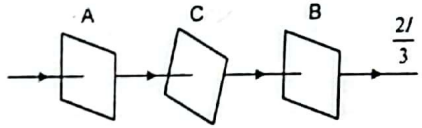
C constant

D zero

17 When a narrow beam of plane-polarised light passes through an ideal polariser A, the light intensity is observed to be I. When an identical polariser B is placed behind A, it is observed that the light intensity beyond B is still I.



A third identical polariser C is now inserted between A and B, causing the light inten emerging from B to become $\frac{2I}{3}$.

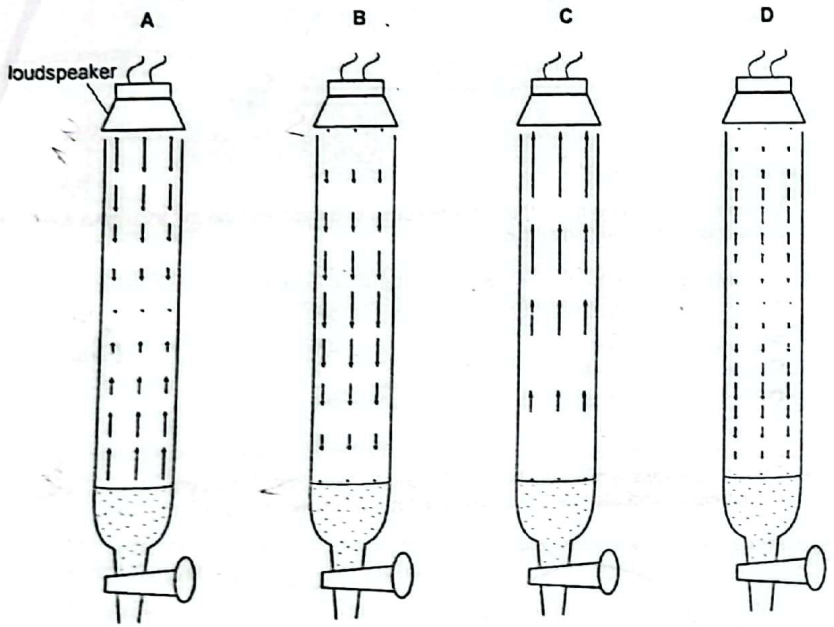


What is the angle between the axes of polarisation of the polarisers A and C?

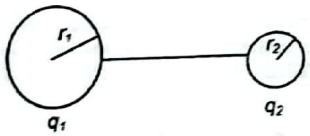
A 25.4° B 35.3° D 55.6°

18 A loudspeaker generating a sound of a fixed frequency is held above the top of a burette filled with water. The water gradually runs out of the burette until a maximum loudness of the sound is heard.

Which of the following best shows a possible standing wave pattern set up by air molecules in the burette at this position?



19 Two spherical conductors of radii r_1 and r_2 are separated by a distance much greater than the radius of either sphere. The spheres are connected by a conducting wire as shown below. The charges on the spheres in equilibrium are q_1 and q_2 respectively. Find the ratio of the electric field at the surface of sphere 1 to the electric field at the surface of sphere 2.

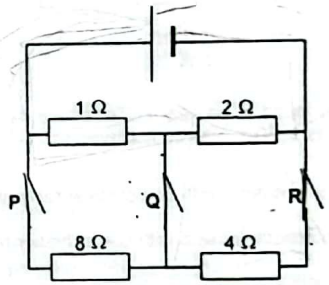


A $\sqrt{\frac{r_2}{r_1}}$ B $\frac{r_2}{r_1}$ C $\frac{r_2^2}{r_1^2}$ D 1

20 A copper wire of length l and diameter d has potential difference V applied at its two ends. The drift velocity of the electrons is v_d. If the diameter of copper wire is changed to $\frac{d}{3}$, the drift velocity becomes

A $9\,v_d$ B $v_d / 9$ C $v_d / 3$ D v_d

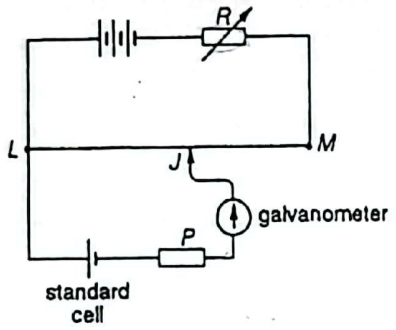
21 The figure below shows the arrangement of four resistors, each with a different resistance.



Which of the following switch settings will produce the greatest current in the circuit?

	P	Q	R
A	Open	Open	Open
B	Open	Closed	Closed
C	Closed	Open	Closed
D	Closed	Closed	Closed

22 A potentiometer is to be calibrated with a standard cell using the circuit as shown.



The balance point is found to be near *L*. To reduce the percentage uncertainty, the balance point should be nearer *M*. This may be achieved by

A replacing the galvanometer with one of lower resistance.

B replacing the potentiometer wire with one of higher resistance per unit length.

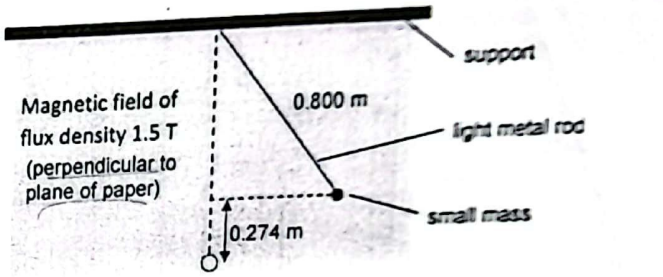
C increasing the resistance *R*.

D removing the resistor *P*.

23 Two very long, straight, parallel wires carry equal steady current *I* in opposite directions. The distance between the wires is *d*. At a certain instant of time, a point charge *q* is at a point equidistant from the two wires, in the plane of the wires. Its instantaneous velocity *v* is perpendicular to this plane. The magnitude of the force due to the magnetic field acting on the charge at this instant is

A 0 N B $\frac{\mu_0 Iqv}{2\pi d}$ C $\frac{\mu_0 Iqv}{\pi d}$ D $\frac{2\mu_0 Iqv}{\pi d}$

24 A small mass hangs at the end of a thin light metal rod of length 0.800 m hinged at one end to a support. The mass is brought to a height of 0.274 m. It is then released from rest to oscillate in a uniform magnetic field of magnetic flux density 1.5 T as shown.



Which of the following gives the average speed of the rod and the instantaneous e.m.f. induced in the rod at its lowest point of oscillation?

	average speed of the rod / m s^{-1}	induced e.m.f. / V
A	2.32	1.4
B	2.32	2.8
C	1.16	1.4
D	1.16	2.8

25 Fig. 25 (a) shows two concentric circular conductors lying in the same plane. The current in the outer loop is clockwise and changes with time as shown in Fig. 25 (b).

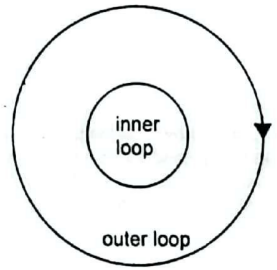


Fig. 25 (a)

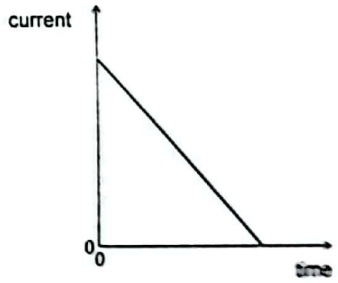


Fig. 25 (b)

The induced current in the inner loop is

A constant in the clockwise direction.

B variable in the clockwise direction.

C constant in the anticlockwise direction.

D variable in the anticlockwise direction.

26 Fig. 26 (a) and (b) shows two separate types of alternating potential difference with the same peak voltage (V_p) applied across a load resistor R.

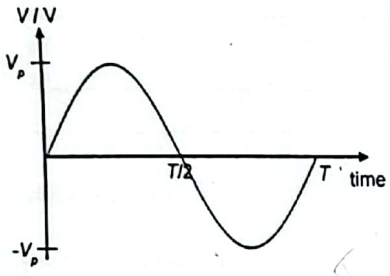


Fig. 26 (a)

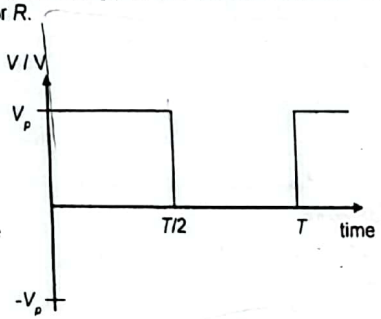


Fig. 26 (b)

What is the ratio $\frac{\text{root-mean-square potential difference for (a)}}{\text{root-mean-square potential difference for (b)}}$?

A 0.5 B 0.7 C 1 D 1.4

27 The continuous optical spectrum of light from the Sun, observed from the Earth is crossed by dark lines at particular wavelengths. The photosphere is the outer layer of gas around the Sun's core. Which one of the following statements correctly accounts for these dark lines?

A The elements that exist in the photosphere which are hotter than the Sun's inner regions, absorb the photons emitted from the Sun.

B The elements that exist in the solar interior absorb the photons emitted from the Sun.

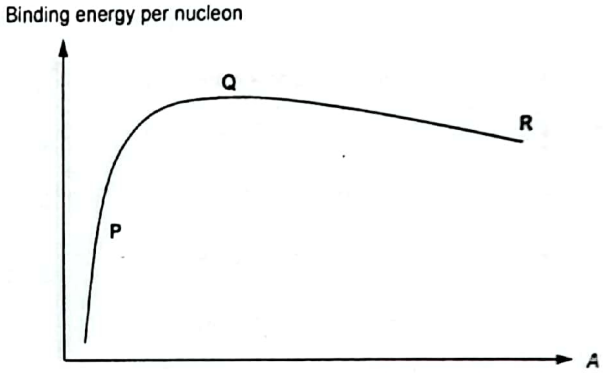
C The elements found in the Earth's atmosphere absorb the photons emitted from the Sun.

D The elements that exist in the cooler photosphere absorb the photons emitted from the Sun.

28 Electrons in a cathode ray tube are accelerated from rest through a potential difference V. What percentage change in the de Broglie wavelength associated with these electrons will occur if the potential difference through which these electrons are accelerated is doubled?

A 29% decrease
B 50% decrease
C No change
D 29% increase

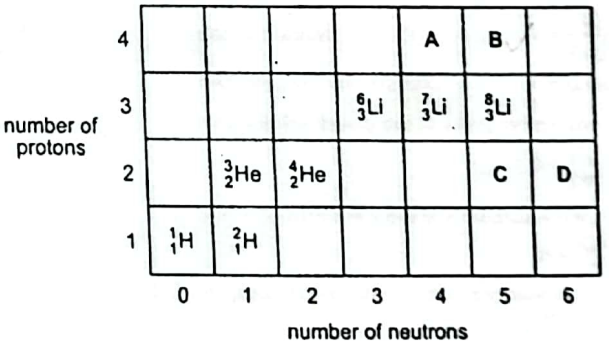
29 The graph below shows how the binding energy per nucleon of a nucleus varies with nucleon number A.



Which one of the following statements is not true?

A Nuclear fusion reactions bring nuclei closer to region Q.
B Nuclei in region Q are more stable than nuclei in region R.
C Energy is released in nuclear fission reactions from nuclei in region P.
D The binding energy per nucleon increases most significantly at lower nucleon numbers.

30 The grid shows a number of nuclides arranged according to the number of protons and the number of neutrons in each. A nucleus of the nuclide $^{8}_{3}\text{Li}$ decays by emitting a β particle. What is the resulting nuclide?



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