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NANYANG JUNIOR COLLEGE
Science Department

JC 2 PRELIMINARY EXAMINATION

Higher 2

PHYSICS 9646/01

Paper 1 Multiple Choice

18 September 2013

1 hour 15 minutes

Additional Materials : Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil. Do not use staples, paper clips, highlighters, glue or correction fluid. Write your name, Centre number and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **TWENTY-TWO** 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 Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

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.

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
permeability of free space,	μ_o	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_o	=	8.85×10^{-12} Fm^{-1} $(1 / (36\ \pi)) \times 10^{-9}$ Fm^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
molar gas constant,	R	=	8.31 J K^{-1} mol^{-1}
the Avogadro constant,	N_A	=	6.02×10^{23} mol^{-1}
the Boltzmann constant,	k	=	1.38×10^{-23} J K^{-1}
gravitational constant,	G	=	6.67×10^{-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	=	Pgh
gravitational potential,	ϕ	=	$-Gm / r$
displacement of particle in s.h.m.	x	=	$x_o \sin \omega t$
velocity of particle in s.h.m.	v	=	$v_o \cos \omega t$
		=	$\pm \omega\sqrt{\left(x_o^{\,2} - x^2\right)}$
mean kinetic energy of a molecule of an ideal gas	E	=	$\frac{3}{2}kT$
resistors in series,	R	=	$R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$
electric potential,	V	=	$Q / 4\pi\varepsilon_o r$
alternating current/voltage,	x	=	$x_o \sin \omega t$
transmission coefficient,	T	α	exp(-2kd)
	where k	=	$\sqrt{\frac{8\pi^2 m\left(U - E\right)}{h^2}}$
radioactive decay,	x	=	$x_o \exp(-\lambda t)$
decay constant	λ	=	$\frac{0.693}{t_{1/2}}$

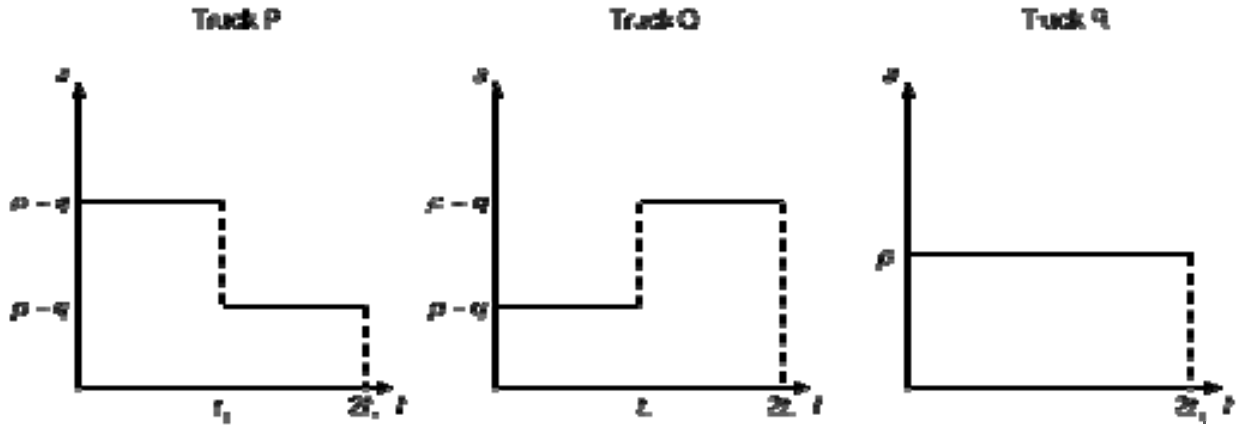
1 One form of Bernoulli's principle for incompressible fluid flows states that throughout the flow, a certain quantity X remains constant.
In the following expressions, m is mass, v is velocity, P is pressure, and ρ is density. Which of the expressions could possibly be correct?

A $X = \frac{1}{2}mv^2 + p\rho$ **B** $X = \frac{1}{2}mv^2 + \frac{p}{\rho}$ **C** $X = \frac{1}{2}v^2 + p\rho$ **D** $X = \frac{1}{2}v^2 + \frac{p}{\rho}$

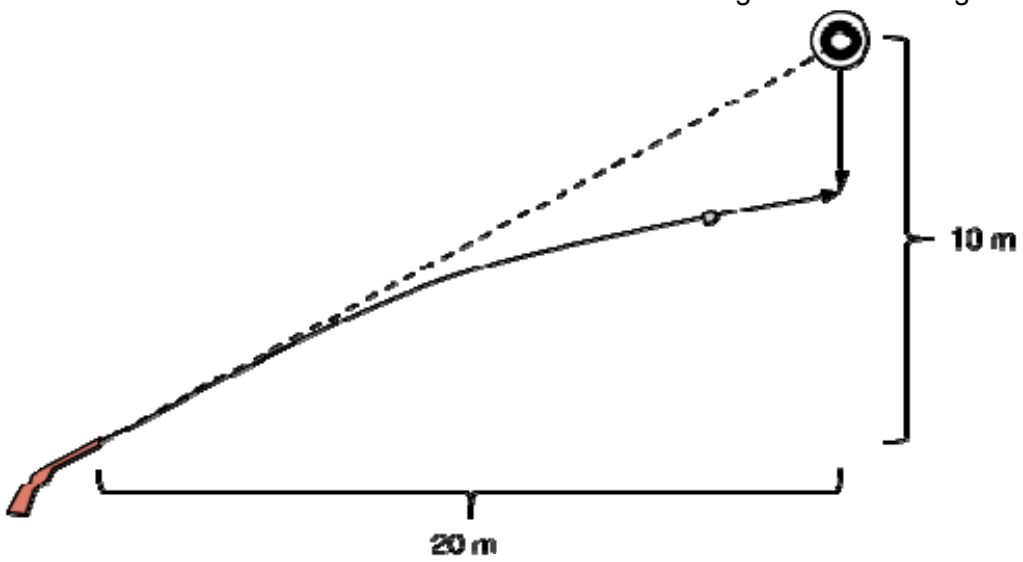
2 Trucks P, Q, and R are at rest side by side. They begin accelerating at the same time. The graph of their acceleration over time is shown below.

At time $2t_1$, which truck(s) will have covered the largest distance?

A Truck P
B Truck Q
C Truck R
D Trucks P and Q



3 A hunter aligns his rifle sight with a target. At a signal, the target falls, and the hunter fires at the same time. The bullet takes 0.8 s from the time of the signal to hit the target.



What is the initial speed of the bullet?

A 12.5 m s^{-2}
B 25.4 m s^{-2}
C 28.0 m s^{-2}
D 29.9 m s^{-2}

4 Which of the following statements is true?

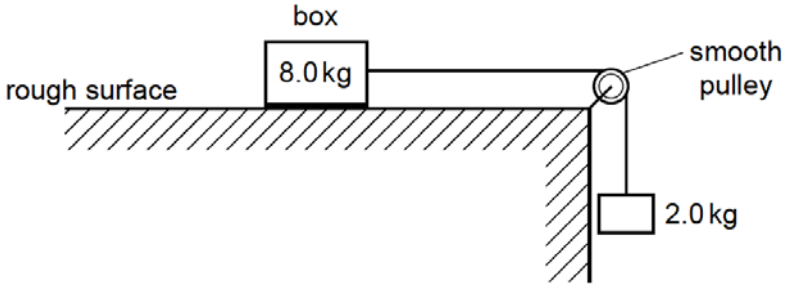
A An object can only be in equilibrium if both its velocity and acceleration are zero.
B An object at rest with average acceleration *a* always travels a distance of $\frac{1}{2}at^2$ in time *t*.
C An object can be moving with constant speed but with non-zero acceleration.
D In projectile motion, an object is at rest at the peak of its trajectory because its resultant acceleration is zero.

5 A projectile of mass *m* is fired from the ground with a velocity *v* at angle of 45° from the horizontal.

Neglecting air resistance, what is the direction and magnitude of the change in momentum of the projectile from the instant after it is fired to the instant just before it reaches the ground again?

	direction	magnitude
A	–	zero
B	→	*mv*
C	→	$\sqrt{2}\ mv$
D	↓	$\sqrt{2}\ mv$

6 A box of mass 8.0 kg rests on a horizontal, rough surface. A string attached to the box passes over a smooth pulley and supports a 2.0 kg mass at its other end.



When the box begins to move, a frictional force of 6.0 N acts on it.

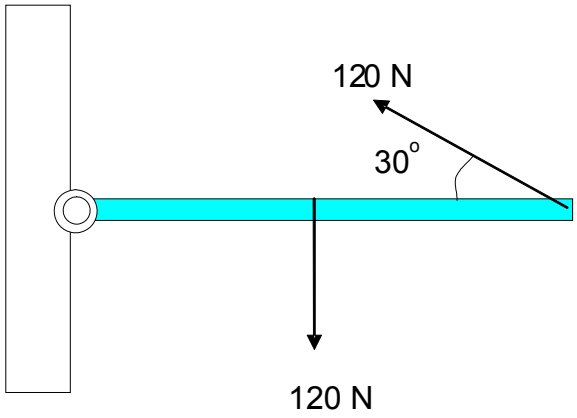
What is the acceleration of the box?

A 1.4 m s^{-2} **B** 1.7 m s^{-2} **C** 2.0 m s^{-2} **D** 2.5 m s^{-2}

7 A cyclist is moving with constant velocity as shown in the following figure. The rear wheel of the bicycle is powered by cyclist through a chain.

	The number of torque on the rear wheel	The direction of the frictional force on the rear wheel by the ground	Resultant torque on the rear wheel
A	1	left	clockwise
B	2	right	zero
C	2	left	zero
D	1	right	anticlockwise

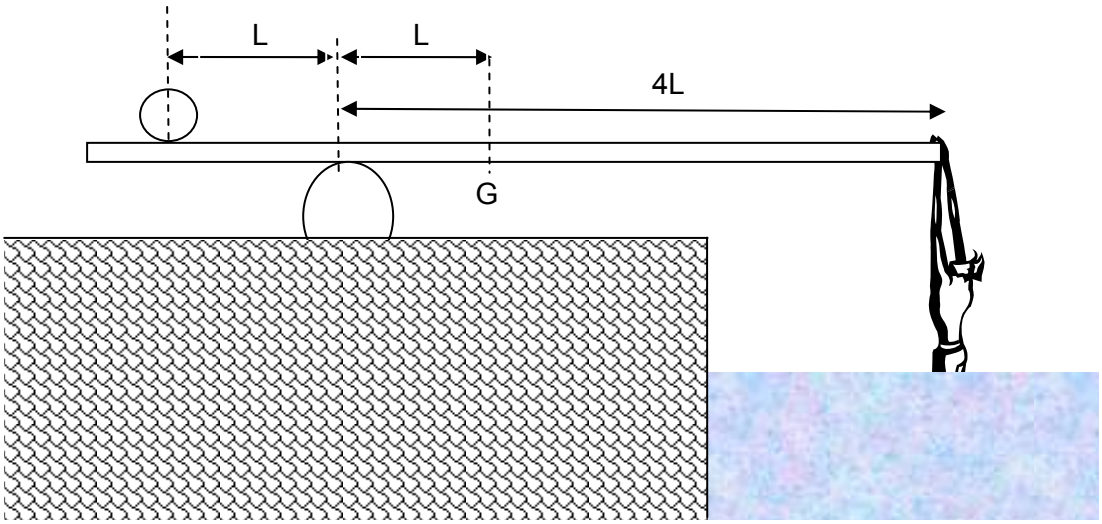
8 A uniform beam is mounted horizontally by a hinge on the wall and a rope at the other end. The weight of the beam is 120 N and the force of the rope is 120 N at an angle 30° as shown. Which of the followings gives the correct values of the reaction *R* on the beam by the hinge and the angle θ between *R* and the wall?



	R/N	θ
A	60	0°
B	104	90°
C	120	60°
D	164	30°

9 Fig. 9 shows a diving-board held in position by two supports. A diver of weight *W* is hanging stationary at the end of the board with his body displaces water of weight 0.30*W*. Point G is the centre of gravity of the diving board of weight 1.4*W*. Which of the followings is the correct value of the vertical force acting on the bottom support by the dive board?

Fig. 9



A 2.1 *W* **B** 4.2 *W* **C** 5.4 *W* **D** 6.3 *W*

10 A body of mass 2.0 kg falls with a terminal velocity of 20 m s^{-1}. Which of the following gives the correct values of the rates of work done by the weight and air resistance, and the rate of change in total energy (kinetic energy + gravitational potential energy) of the body? (take g = 10 m s^{-2})

	Rate of work done by weight / W	Rate of work done by air resistance / W	Rate of total energy change of body / W
A	+400	-400	0
B	-400	+400	0
C	+400	-400	-400
D	zero	-400	-400

11 The diameter of the Singapore flyer is D and the maximum mass of each capsule and passengers is in average M. One day the flyer is operating with an average linear speed v with maximum passengers in all the N capsules. Ignore all frictional forces, the total work done in moving the whole flyer one full round with constant angular velocity is

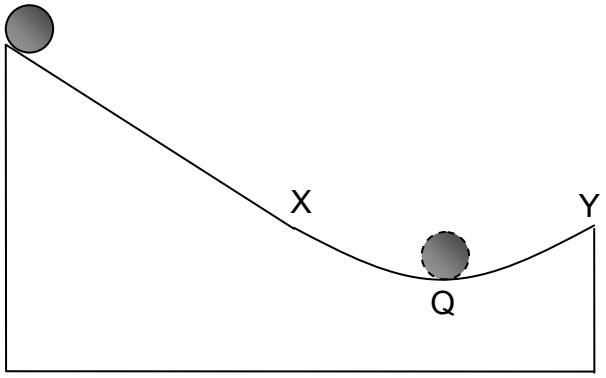
A 0

B $\frac{1}{2}NMgD$

C $NMgD + \frac{1}{2}NMv^2$

D $2MgD + \frac{1}{2}NMv^2$

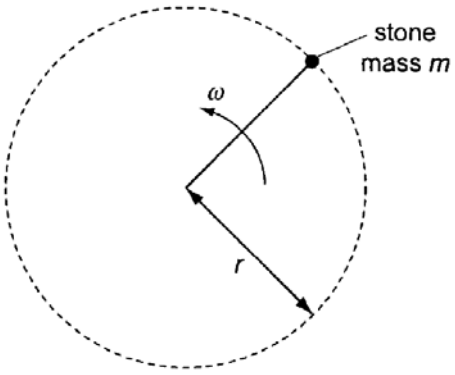
12 A steel ball is placed at the top of a smooth and frictionless ramp and released. The ramp is curved in a circular arc from X to Y.



The acceleration of the ball at position Q is best represented by the vector

A ← **B** → **C** ↓ **D** ↑

13 A stone with mass *m* is attached to light rod. The stone is rotated in a vertical circle of radius *r* with a constant angular speed *ω* as shown.

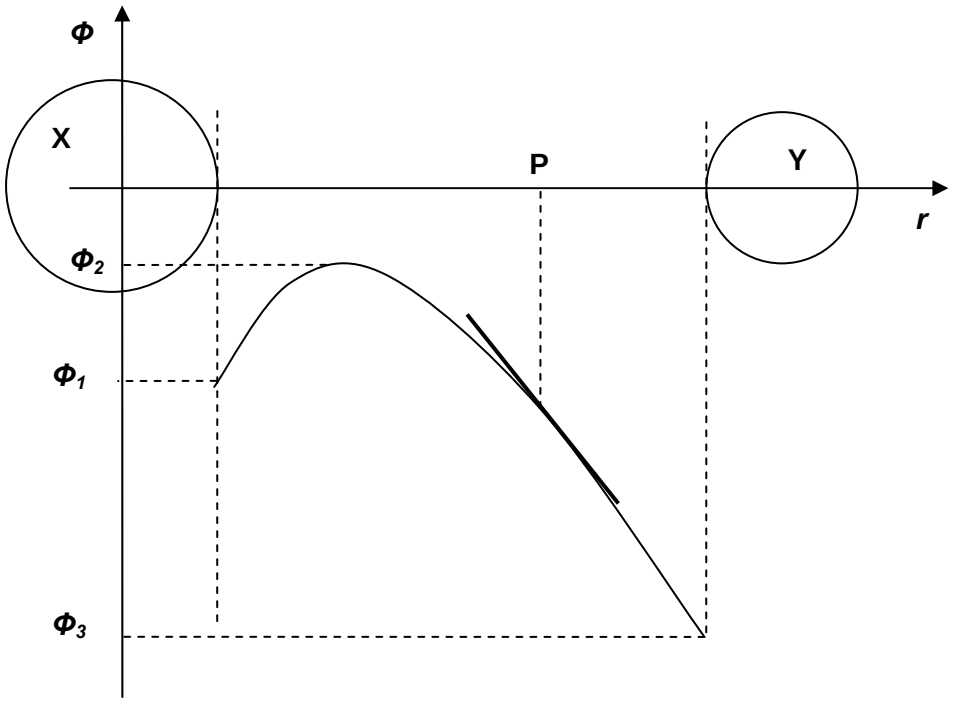


The acceleration of free fall is *g*.

What is the difference between the maximum and minimum magnitude of the tension in the light rod during one revolution of the stone?

A zero **B** $2mg$ **C** $mr\omega^2$ **D** $2mr\omega^2$

14 Fig. 14 shows the variation of the resultant gravitational potential of two isolated planets X and Y with the distance r from planet A.



A rocket of mass *m* is launched from the surface of planet X to the surface of planet Y, Assume that the fuel of the rocket is completely consumed in a negligible distance compared to the distance between the two planets. Which of the following statement is correct?

A In order to reach planet Y, the minimum initial kinetic energy of the rocket is given by $m(\Phi_1 - \Phi_3)$.

B The minimum kinetic energy of the rocket when arriving planet Y is $m(\Phi_2 - \Phi_3)$.

C The mass of planet X is larger than that of planet Y.

D The gradient of the tangent of the graph at point P is the gravitational field strength due to planet Y.

15 There are two isolated planets P and Q of masses M_P and M_Q respectively. Their centres are of distance *L* apart and they rotate with a uniform angular velocity ω about an axis S which intersects the line joining their centres perpendicularly as shown in Fig. 15. If the distance of planet P from the centre S is *R*, which of the following expressions <u>does not</u> give the expression for the centripetal force on planet Q?

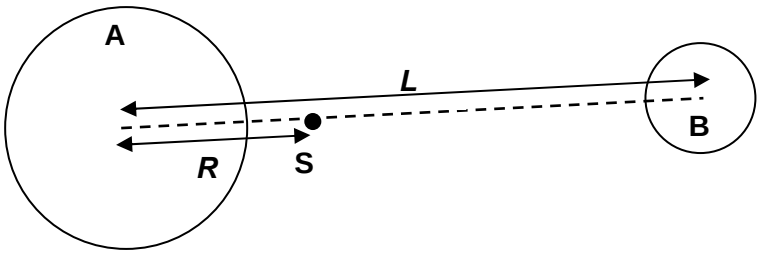


Fig. 15

A $\frac{GM_PM_Q}{L^2}$ **B** $\frac{GM_PM_Q}{(L-R)^2}$ **C** $M_P R\,\omega^2$ **D** $M_Q (L - R)\,\omega^2$

16 A point mass moves with simple harmonic motion. Which of the following statements is true?

A The maximum kinetic energy of the mass is independent on the frequency of the oscillation.

B The time taken for the system to change from maximum kinetic energy to maximum potential energy is a half of the period of the oscillation.

C An oscillation system with larger amplitude will have a greater potential energy.

D The period of an oscillation system is dependent to its amplitude..

17 An object undergoes simple harmonic motion with an amplitude *A*, and its total energy is *E*. What is the displacement of the object when its kinetic energy is E/4 ?

A $A\frac{\sqrt{3}}{2}$ **B** $\frac{A}{4}$ **C** $\frac{3A}{4}$ **D** $\frac{A}{2}$

18 A gas tank springs a leak, and gas begins leaking out quickly. Which of the following options correctly shows the changes occurring in the gas inside the tank?

	Pressure	*Average speed*
A	Increases	Increases
B	Increases	Decreases
C	Decreases	Increases
D	Decreases	Decreases

19 The First Law of Thermodynamics can be applied to the pumping of a bicycle tyre. In this process, air is quickly forced into the tyre by mechanical action.

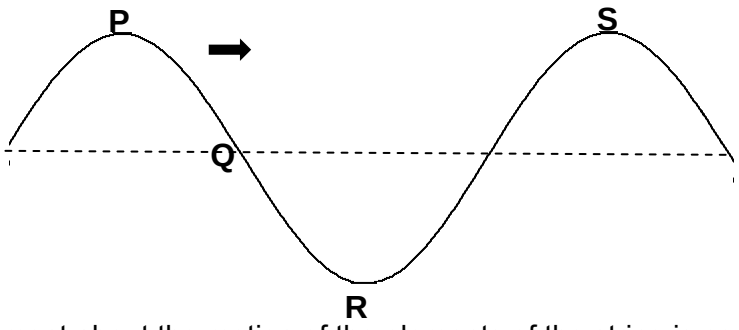
According to such an analysis, how would the following quantities in the tyre change?

	Internal Energy	***Heat supplied***	***Work done on system***
A	Increases	Negligible	Positive
B	No change	Positive	Negative
C	Increases	Negligible	Zero
D	No change	Negative	Positive

20 A point source of sound emits energy equally in all directions at a constant rate and a person 8 m from the source listens. After a while, the power of the source is halved. If the person wishes the sound to seem as loud as before, how far should he be now from the source?

A 2 m **B** $2\sqrt{2}$ **C** $4\sqrt{2}$ **D** $8\sqrt{2}$

21 The graph shows the shape at a particular instant of part of a transverse wave travelling along a string.



Which statement about the motion of the elements of the string is correct?

A The kinetic energy of the element at P is a maximum.

B The displacement of the element at Q is always zero, it is a node.

C The total kinetic and potential energy at the element R is a minimum.

D The acceleration of the element at S is a maximum.

22 An pipe of effective length 0.60 m is alternated opened at both ends and closed at one end. Given that the speed of sound in air in 300 m s^{-1}, the possible resonant frequencies are

	Opened at both ends	**Closed at one end**
A	125 Hz, 750 Hz	500 Hz, 750 Hz
B	125 Hz, 375 Hz	250 Hz, 500 Hz
C	250 Hz, 500 Hz	125 Hz, 500 Hz
D	250 Hz, 750 Hz	375 Hz, 625 Hz

23 In a diffraction grating experiment, the first order image of the 435.8 nm blue light from a commercial mercury vapour discharge lamp occurred at an angle of 15.8°. A first order red line was also observed at 23.7°, thought to be produced by an impurity in the mercury.

The wavelengths of red lines of various elements are listed. Which element is the impurity in the mercury lamp?

	Element	Wavelength/ nm
A	Zinc	636.0
B	Cadmium	643.3
C	Hydrogen	656.3
D	Neon	670.8

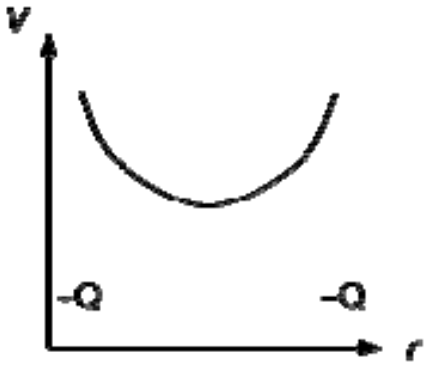
24 Points Q, R, S, and T are equally spaced, as shown below. A positive charge $+q$ is placed at R, and a negative charge $-q$ is placed at S. The work done in bringing an electron to point Q is w.

If another positive charge $+q$ is placed at T, what is the work done in bringing an electron to point Q?

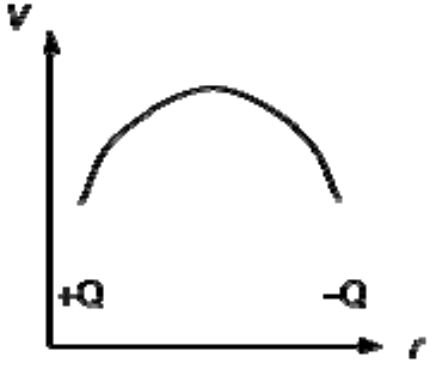
A 1/3 w **B** 2/3 **C** 5/3 w **D** 22/9 w

25 Which of the following graphs shows the electric potential along a straight line between two charges +Q and –Q?

A

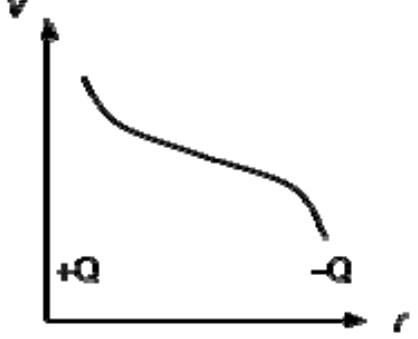


B

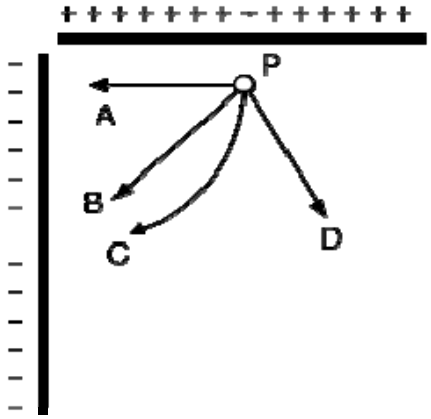


C

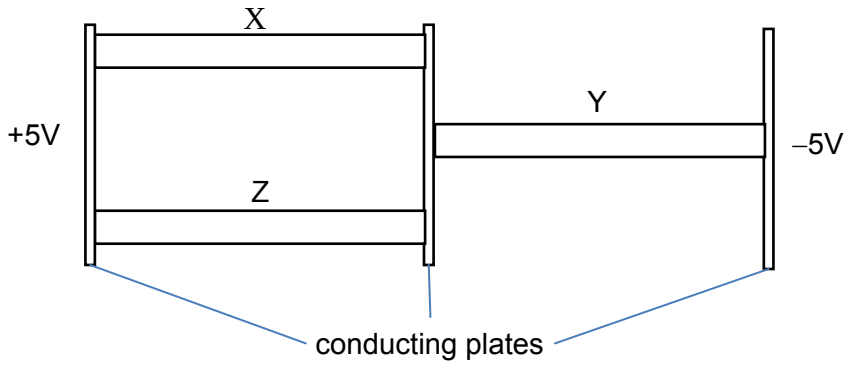
D



26 Two oppositely charged plates are placed next to each other, as shown.
A positively charged particle is initially at rest, at position P. Which of the paths A, B, C, or D, is it most likely to follow subsequently?

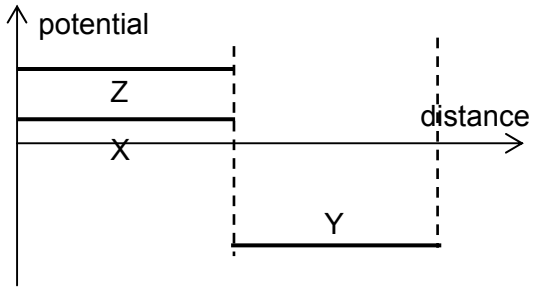


27 Three conductors X, Y and Z are connected using conducting plates of negligible resistance in the arrangement shown below.

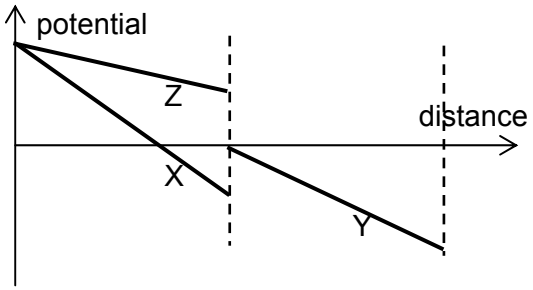


The three conductors are of the same length and cross-sectional area, but the resistivities of the materials they are made of ρ_X, ρ_Y and ρ_Z are such that $\rho_X > \rho_Y > \rho_Z$.

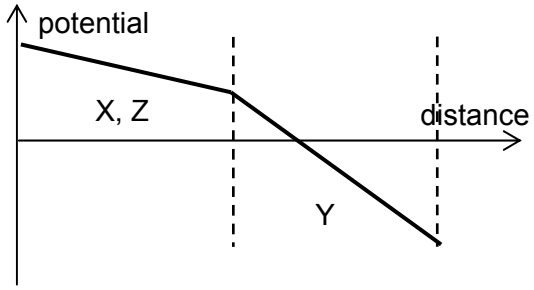
Which of the following graphs best shows the variation of potential along axis of the conductors when a potential difference of 10 V is applied across the arrangement?



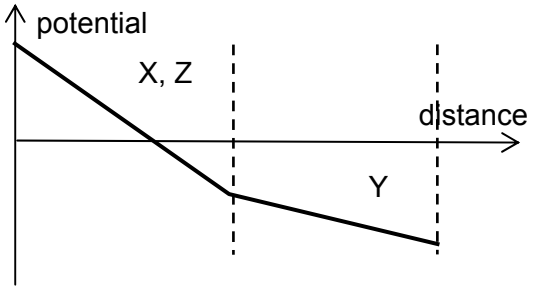
A



B

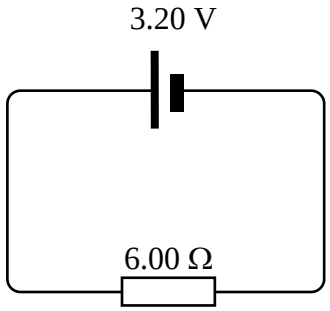


C



D

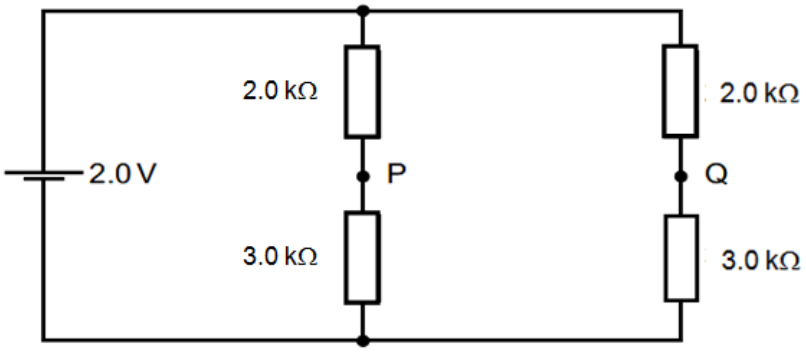
28 A cell of e.m.f. 3.20 V is connected to a 6.00 Ω resistor in the circuit shown below.



If the power dissipated by the resistor is 1.40 W, how much power is lost in the cell?

A 0.15 W **B** 0.25 W **C** 0.43 W **D** 0.65 W

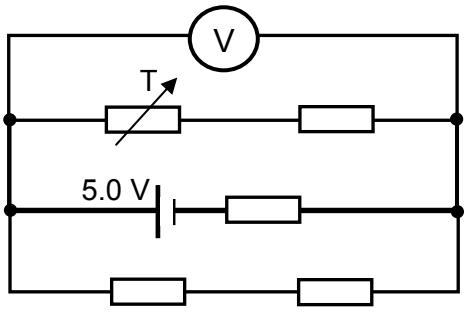
29 A cell of e.m.f. 2.0 V and negligible internal resistance is connected to the network of resistors shown below. P and Q are points in the circuit.



Calculate the potential difference between P and Q.

A 0 V **B** 0.20 V **C** 0.60 V **D** 1.0 V

30 A cell of e.m.f. 5.0 V and negligible internal resistance is connected to four similar resistors and a variable resistor T, as shown.

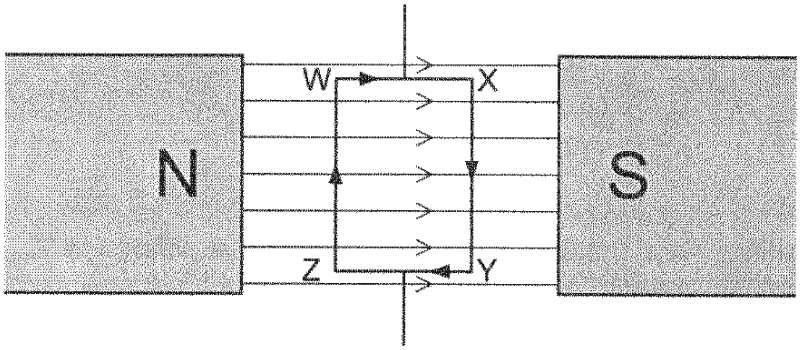


Resistance of each resistor is 1.0 k□ and resistance of T is 5.0 k□.

What is the reading of the ideal voltmeter?

A 0 V **B** 2.0 V **C** 3.0 V **D** 5.0 V

31 In an electric motor, a rectangular coil WXYZ has 20 turns and is in a uniform magnetic field of flux density 0.83T.



The lengths of sides XY and ZW are 0.17 m and of sides WX and YZ are 0.11 m. The current in the coil is 4.5 A.

What is the maximum torque provided by the motor?

A 0.070 Nm **B** 0.63 Nm **C** 1.4 Nm **D** 2.8 Nm

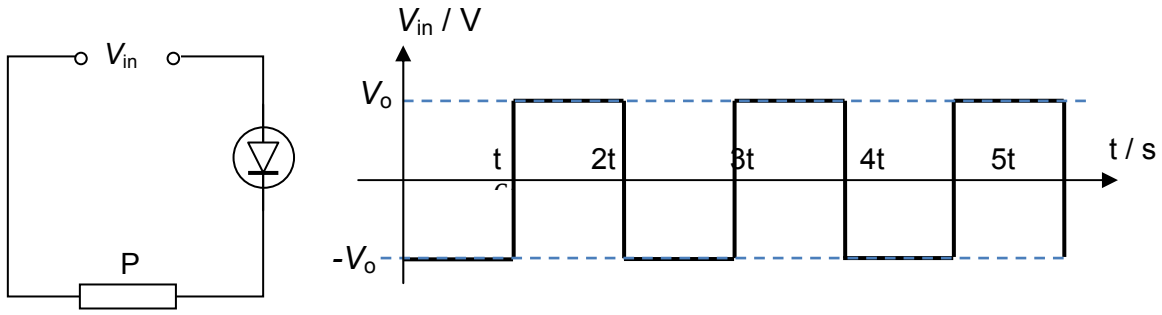
32 A neutral sub-atomic particle at rest in a magnetic field of flux density *B*. It spontaneously decays into two particles of mass *m* each. One of the particles has a negative charge –*q*. The particles move with velocities perpendicular to the magnetic field. After what time will the particles collide?

A π **B** $\frac{qB}{m}$ **C** $\frac{m\pi}{qB}$ **D** $\frac{2m\pi}{qB}$

33 A circular coil has resistance *R* and area *A*. The coil is placed in a uniform magnetic field of strength *B* such that its plane is perpendicular to the magnetic field lines. The plane of the coil is now rotated through 90°. The magnitude of the charge that flows in the coil is

A Zero **B** $\frac{BA}{R}$ **C** $\frac{R}{BA}$ **D** BAR

34 A rectifier is connected in series with load P and an alternating voltage supply as shown in the figure below.



What is the value of the r.m.s. voltage across load P?

A 0.18 V_o **B** 0.50 V_o **C** 0.71 V_o **D** 1.0 V_o

35 In an ideal transformer, the most important function of the soft-iron core is

A to reduce eddy-currents.

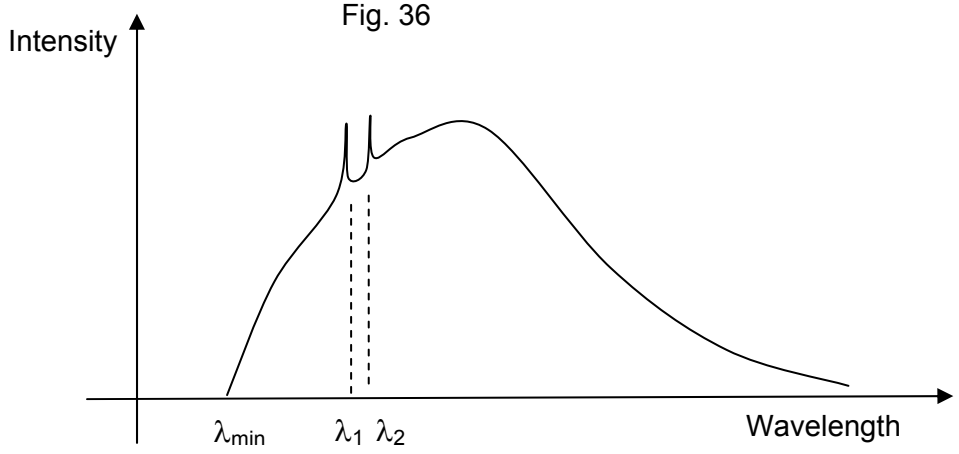
B to improve the flux-linkage between the primary and secondary coils.

C to dissipate the heat generated by the two coils.

D to produce a uniform magnetic field in the two coils

36 Fig. 36 below shows a typical X-ray spectrum produced when electrons are accelerated through a potential difference and are then stopped in a metal target.

Fig. 36



Which of the following is not correct?

	Feature(s) on the graph	Is dependent on
A	The wavelengths (λ_1, λ_2) of the peaks on the graph	the target material.
B	The minimum wavelength λ_{min} of the X-rays produced	the target material
C	The minimum wavelength λ_{min} of the X-rays produced	the potential difference used to accelerate the bombarding electrons.
D	The maximum intensity of the X-rays produced.	the potential difference used to accelerate the bombarding electrons.

37 Which statement describes correctly how scanning tunnelling microscopes work in obtaining an atomic-scale image of a surface?

A The position of the tip of the microscope in the Z-axis must be adjusted accordingly to keep the tunnelling current a constant during the scan on a surface lying in the X-Y plane.

B The width of the gap between the tip of the microscope and the surface must be varied continuously to keep the tunnelling current a constant during the scan.

C The voltage applied between the tip of the microscope and the surface must be varied continuously in order to keep the tunnelling current a constant during the scan.

D The voltage applied between the tip of the microscope and the surface must be high enough in order to cause a discharge in the gap and thus allowed a tunnelling current to flow.

38 Stimulated emission occurs in the laser when a photon P causes the emission of a photon Q. Which of the following statements is true of the photons?

A They have different frequencies but are in phase and traveling in the same direction.

B They have the same frequency, are π rad out of phase and traveling in the same direction.

C They have the same frequency, are in phase and traveling in the different directions.

D They have the same frequency, are in phase and traveling in the same direction.

39 The resistivity of the intrinsic semiconductor silicon decreases from 400 Ωm at 20°C to 40 Ωm at 60°C.

Which statement, using band theory, best explains the change in resistivity of silicon with an increase in temperature?

A Conduction band electrons which carry current move faster.

B More electrons can move through the valence band taking part in conduction.

C More valence band electrons can be promoted to the conduction band.

D The energy gap between the valence and conduction bands decreases

40 What may not be conserved in nuclear processes?

A charge

B momentum

C the total number of neutrons

D the total number of nucleons