INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION 2
in preparation for General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME			
CLASS		INDEX NUMBER	

PHYSICS 9646/01

Paper 1 Multiple Choice **16 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, civics group and index number on the Answer sheet in the spaces provided unless this has been done for you.

There are **forty** 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	$= 3.00 \times 10^{8}$ m s^{-1}
permeability of free space,	μ_o	$= 4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_o	$= 8.85 \times 10^{-12}$ 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	$= p\Delta V$
mean kinetic energy of a molecule of an ideal gas	E	$= \frac{3}{2}kT$
hydrostatic pressure,	p	$= \rho gh$
gravitational potential,	Φ	$= -\frac{GM}{r}$
displacement of particle in s.h.m.	x	$= x_o \sin \omega t$
velocity of particle in s.h.m.	v	$= v_o \cos \omega t$
		$= \pm\omega\sqrt{\left(x_o^{\,2} - x^2\right)}$
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	$= \exp(-2kd)$
		where $k = \sqrt{\frac{8\pi^2 m(U-E)}{h^2}}$
radioactive decay,	x	$= x_o \exp(-\lambda t)$
decay constant,	λ	$= \frac{0.693}{t_{½}}$

1 Thermal conductivity *k* is the property of a material that indicates its ability to conduct heat. The rate of flow of heat energy $\frac{dQ}{dt}$ can be found from the equation $\frac{dQ}{dt} = kA\frac{T_2 - T_1}{L}$ where *k* is the thermal conductivity, *A* is the cross sectional area of the conducting surface $T_2 - T_1$ is the temperature difference across the surface and *L* is the thickness of the conducting surface separating the two temperatures.

What is the S.I. unit for *k*?

A $W\ m^{-1}\ K^{-1}$ **B** $W\ m^{-2}\ K^{-2}$ **C** $W\ m^{-3}\ K^{-1}$ **D** $J\ m^{-2}\ K^{-1}$

2 A runner runs a distance of 100 metres. Measured with a tape, this has an uncertainty of 20 cm. He clocks 10.0 seconds but knows that the timing has an uncertainty of 0.5 seconds due to human error in the timing.

The average speed of the runner can be expressed as

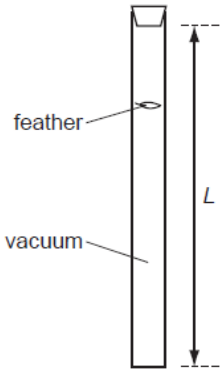
A $10.0 \pm 0.5\ m\ s^{-1}$

B $10.00 \pm 0.52\ m\ s^{-1}$

C $10.0 \pm 0.7\ m\ s^{-1}$

D $10 \pm 3\ m\ s^{-1}$

3 The diagram shows a laboratory experiment in which a feather falls from rest in a long evacuated vertical tube of length *L*.

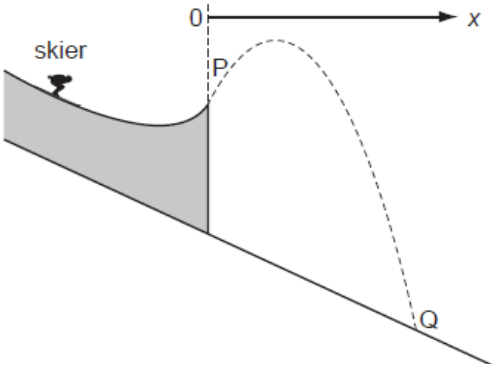


The feather takes time *T* to fall from the top to the bottom of the tube.

How far will the feather have fallen from the top of the tube in time 0.50*T*?

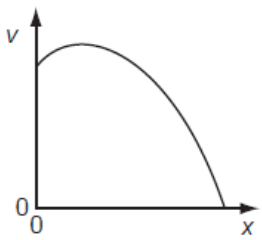
A 0.13 *L* **B** 0.25 *L* **C** 0.38 *L* **D** 0.50 *L*

4 The dotted line shows the path of a competitor in a ski-jumping competition.



Ignoring air resistance, which graph best represents the variation of his speed *v* with the horizontal distance *x* covered from the start of his jump at P before landing at Q?

A



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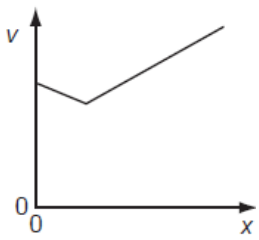
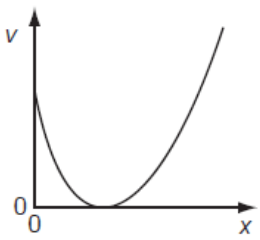
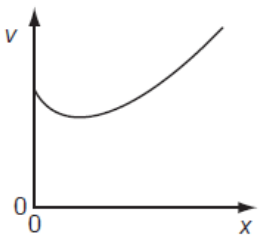


C



D

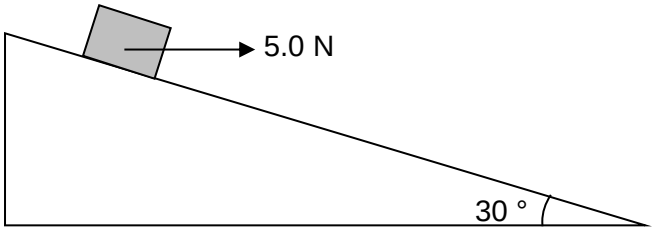


5 In a tropical rainstorm, 40 mm of rain fell in one hour. Assuming that the raindrops struck an adequately drained roof normally with an average speed of 10 m s^{-1}, find the pressure exerted on the roof by the rain.

[Density of water = 1.0×10^3 kg m^{-3}]

A 4.00×10^{-2} Pa **B** 1.11×10^{-4} Pa **C** 1.11×10^{-1} Pa **D** 4.00×10^{2} Pa

6 A block of mass 1.0 kg is pulled from rest down a smooth inclined plane with a constant horizontal force *F* of 5.0 N as shown.



What is the speed of the block after travelling 1.0 m down the slope from its initial position?

A 2.9 m s^{-1} **B** 3.1 m s^{-1} **C** 4.3 m s^{-1} **D** 4.5 m s^{-1}

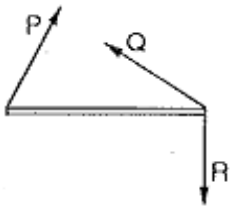
7 A 4.25 g bullet travelling horizontally with a speed of 375 m s^{-1} is fired into a wooden block with mass 1.12 kg, initially at rest on a level frictionless surface. The bullet passes through the block and emerges with its speed reduced to 122 m s^{-1}.

How fast is the block moving just after the bullet emerges from it?

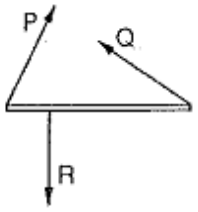
A 0.96 m s^{-1} **B** 1.42 m s^{-1} **C** 9.60 m s^{-1} **D** 21.84 m s^{-1}

8 A light rod is acted upon by three forces P, Q and R.
Which diagram could show the position and direction of each of the forces when the rod is in equilibrium?

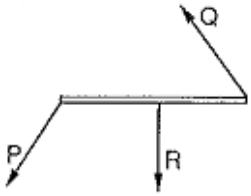
A



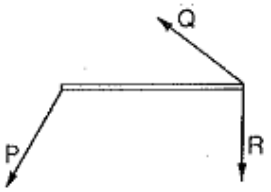
B



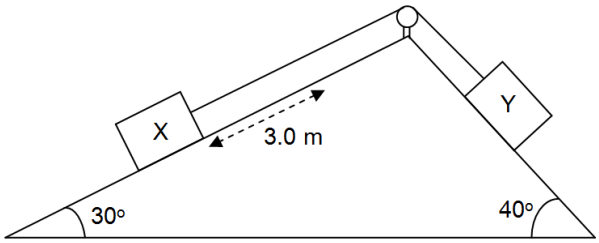
C



D



9 The diagram below shows two boxes X and Y of masses 2.0 kg and 3.0 kg respectively connected by a light inextensible rope passing over a light, free-running pulley. X and Y are on smooth inclined planes. X starts from rest and moves up the plane inclined at 30° to the horizontal.



What will be the final speed of Y after X has travelled 3.0 m along the plane?

A 1.6 m s^{-1} **B** 2.3 m s^{-1} **C** 3.3 m s^{-1} **D** 4.3 m s^{-1}

10 A motor driving a pump raises 0.10 m^3 of water through a vertical height of 5.0 m in a time of 10 minutes.

If the efficiency of the motor is 60%, what is the power input to the motor?
(Take density of water to be 1000 kg m^{-3})

A 4.9 W **B** 13.6 W **C** 8.2 W **D** 490 W

11 A particle of constant mass travels in uniform circular motion.
Which of the following correctly describes the linear velocity, angular velocity and kinetic energy of the particle?

	Linear velocity	Angular velocity	Kinetic energy
A	varying	constant	constant
B	varying	constant	varying
C	constant	varying	constant
D	constant	varying	varying

12 A body is moved from point P on Earth's surface to another point Q further from Earth's centre. Which of the following statements about the gravitational potential energy of the body at the two points is correct? Take the gravitational potential to be zero at an infinite distance from Earth.

A It is positive at both points and numerically greater at Q than at P.

B It is positive at both points and numerically greater at P than at Q.

C It is negative at both points and numerically greater at Q than at P.

D It is negative at both points and numerically greater at P than at Q.

13 Which of the following statements about the weight of a body at the Equator compared with its weight at a pole is correct? Assume the Earth to be a uniform sphere rotating about an axis through the poles.

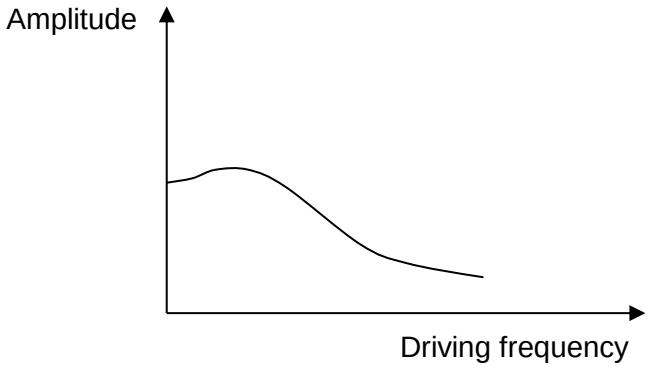
A The weight is greater at the equator because the angular velocity of Earth is greater at the Equator than at a pole.

B The weight is greater at the equator because the weight at the equator is given by the sum of the gravitational attraction of the Earth and the centripetal force due to the circular motion of the body.

C The weight is smaller at the equator because the gravitational attraction of the Earth must provide both the weight and the centripetal force due to the circular motion of the body.

D The weight is the same because the weight is the gravitational attraction of the Earth and for a uniform sphere, even when rotating, this is independent of the position of the body on the Earth.

14 An oscillatory system is made to oscillate by a driving system. The graph below shows how the amplitude of the oscillatory system varies with the frequency of the driving system:



Which of the following statements must be true of the oscillatory system?

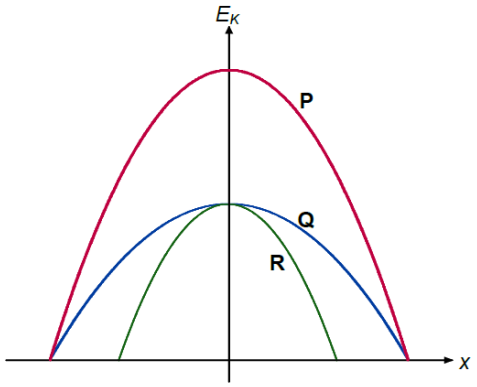
A The graph shows that the oscillatory system is experiencing critical damping.

B The oscillatory system can only complete one oscillation before coming to rest.

C At resonance, the energy supplied to the oscillatory system equals to the energy lost by it.

D At resonance, the amplitude of the oscillatory system decreases with time.

15 The figure below shows plots of kinetic energy E_K vs displacement x for three harmonic oscillations of the same mass.



Which of the following statements about the oscillators is correct?

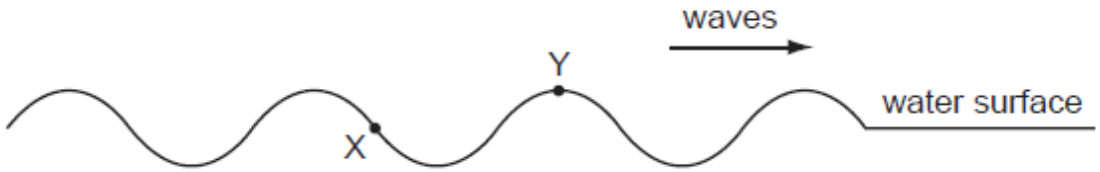
A The maximum potential energy of oscillator Q is greater than oscillator R.

B The maximum linear momentum of oscillator P is the largest.

C The angular frequency of oscillator Q is the largest.

D The angular frequency of oscillator R is smaller than oscillator Q.

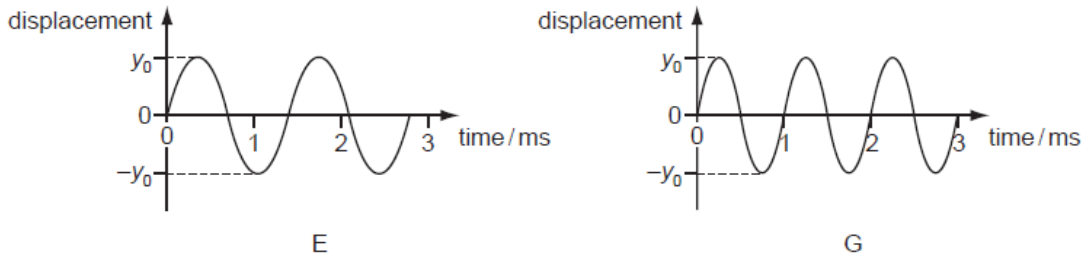
16 X and Y are two points on the surface of water in a ripple tank. A source of waves of constant frequency begins to generate waves which then travel past X and Y, causing them to oscillate.



What is the phase difference between X and Y?

A 45° **B** 135° **C** 180° **D** 270°

17 Two waves E and G are shown. The waves have the same speed.



Which statement is correct?

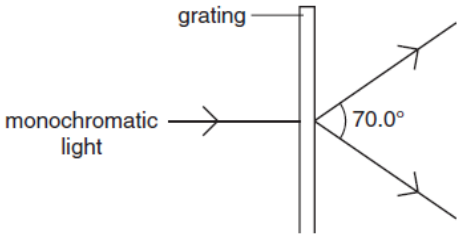
A Wave E has a greater amplitude than wave G.

B Wave E has a greater intensity than wave G.

C Wave E has a smaller frequency than wave G.

D Wave E has a smaller wavelength than wave G.

18 A diffraction grating is used to measure the wavelength of monochromatic light, as shown below.

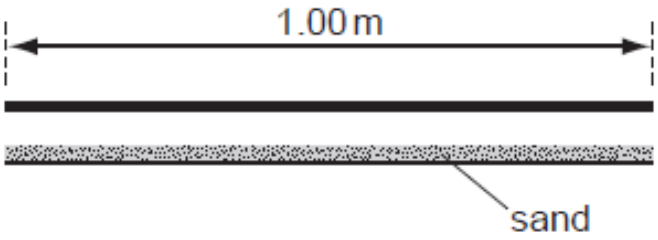


The spacing of the slits in the grating is 1.00×10^{-6} m. The angle between the first order diffraction maximas is 70.0°.

What is the wavelength of the light?

A 287 nm **B** 470 nm **C** 574 nm **D** 940 nm

19 The diagram shows an air-filled pipe open at both ends. The length of the pipe is 1.00 m and the lower surface of the inside of the pipe is covered with a layer of fine sand.



When a source of sound of a single frequency is put near one end of the pipe, the air in the pipe is found to resonate and a pattern in the sand shows that a standing wave containing three heaps of sand formed within the pipe.

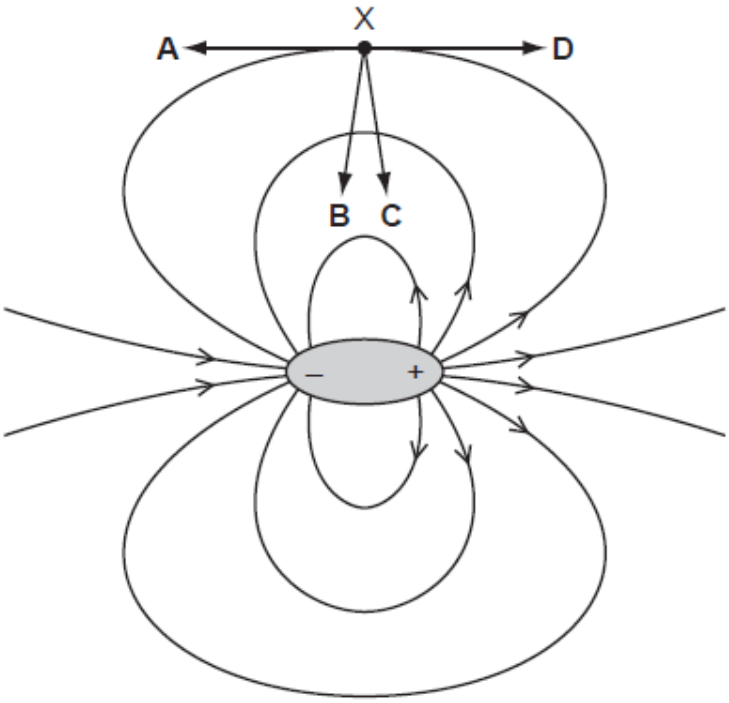
The speed of sound in air is 330 m s^{-1}.

What is the frequency of the sound?

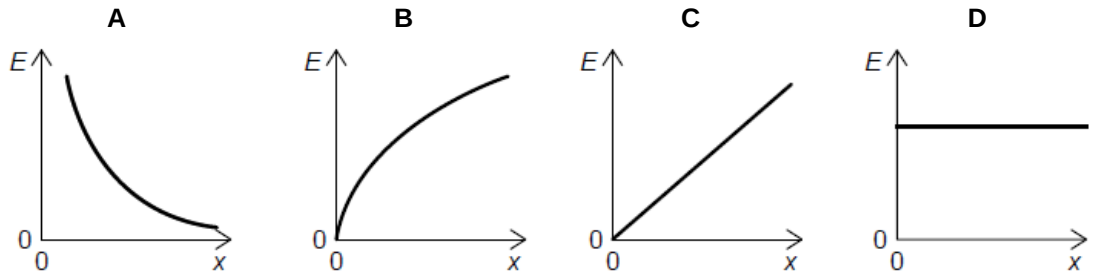
A 330 Hz **B** 495 Hz **C** 990 Hz **D** 1320 Hz

20 A dipole is a pair of one negative charge and one positive charge of equal magnitude. The electric field of a dipole is shown below.

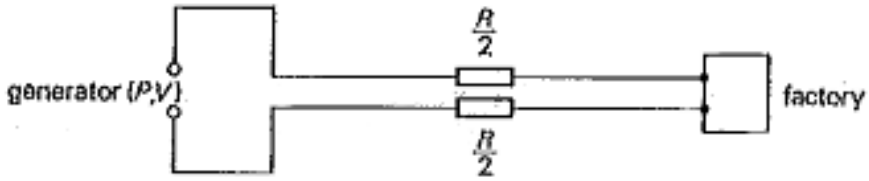
In which direction does the force act on an electron when at point X?



21 Two parallel conducting plates are connected to a battery, one plate to the positive terminal and the other plate to the negative terminal. The plate separation is gradually increased, the plates remaining connected to the battery.
Which graph shows how the electric field E between the plates depends on the plate separation x?



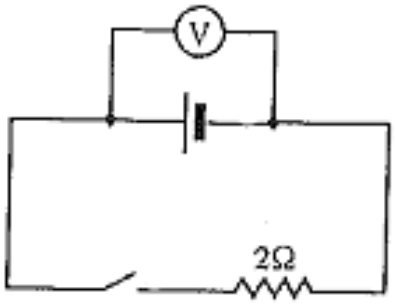
22 A generator, with output power P and output voltage V, is connected to a factory by cables of total resistance R.



What is the power input to the factory?

A P **B** $P - (P/V)R$ **C** $P - (P/V)^2 R/2$ **D** $P - (P/V)^2 R$

23 A battery is connected in series with a 2 Ω resistor and a switch as shown in the figure below. A voltmeter connected across the battery reads 12 V when the switch is open but 8 V when it is closed.

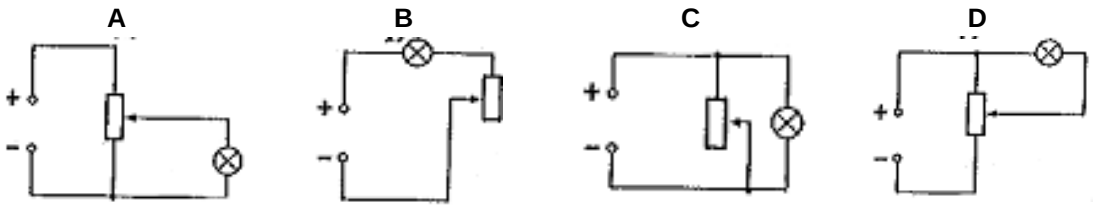


What is the internal resistance of the battery?

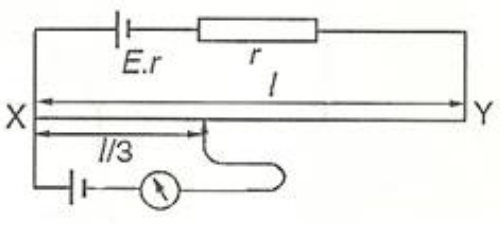
A 0.67 Ω **B** 1.0 Ω **C** 1.3 Ω **D** 4.0 Ω

24 A lamp is connected to a power supply of negligible internal resistance.

Which circuit could **not** be used as a practical means to vary the voltage across the lamp?



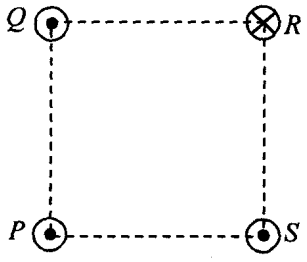
25 A potentiometer has a wire XY of length l and resistance R. It is powered by a battery of e.m.f. E and internal resistance r in series with a resistor of resistance r. With a cell in the branch circuit, the balance point is found to be $l/3$ from X, as shown below.



The e.m.f. of the cell is

A $E/3$ **B** $ER/3(R+r)$ **C** $Er/3(R+2r)$ **D** $ER/3(R+2r)$

26 Four long straight current-carrying wires perpendicular to the plane of the paper are arranged at the corners of a square PQRS as shown. The same current I flowing in the same direction along the wires at P, Q and S while the current flowing along the wire at R is in the opposite direction.



If the wire at P experiences no net force, what is the amount of current flowing in the wire at R?

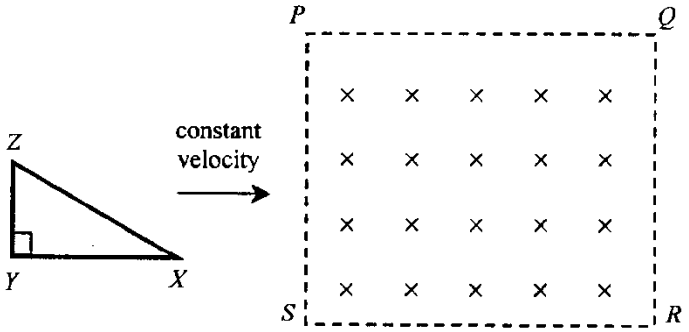
(Note: Magnetic field set up by current-carrying conductor $B = \frac{kI}{r}$ where I is the current, r is the distance between the conductor and a point in the magnetic field and k a constant.)

A $\frac{I}{\sqrt{2}}$ **B** $I/2$ **C** $\sqrt{2}I$ **D** $2I$

27 Protons, each of mass m and charge e, follow a circular path when travelling perpendicular to a magnetic field of uniform flux density B. What is the time taken for one complete orbit?

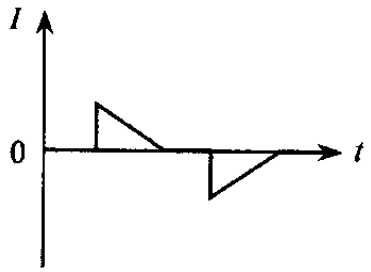
A $\frac{2\pi eB}{m}$ **B** $\frac{m}{2\pi eB}$ **C** $\frac{eB}{2\pi m}$ **D** $\frac{2\pi m}{eB}$

28

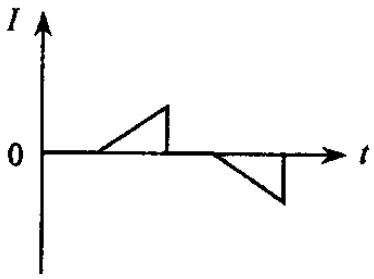


In the above figure, XYZ is a small right-angled triangular metal frame moving with a constant velocity across a rectangular region $PQRS$ with a uniform magnetic field pointing into the paper. Which of the following graphs best shows the variation of the current I induced in the frame with time t?

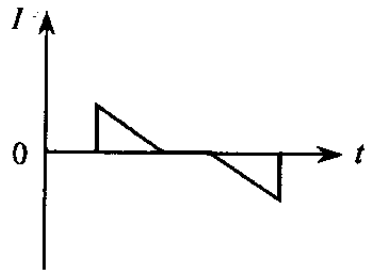
A



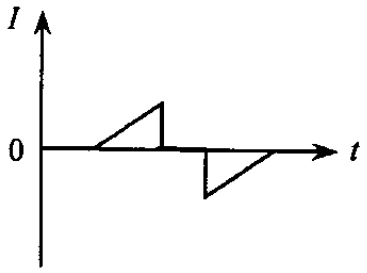
C



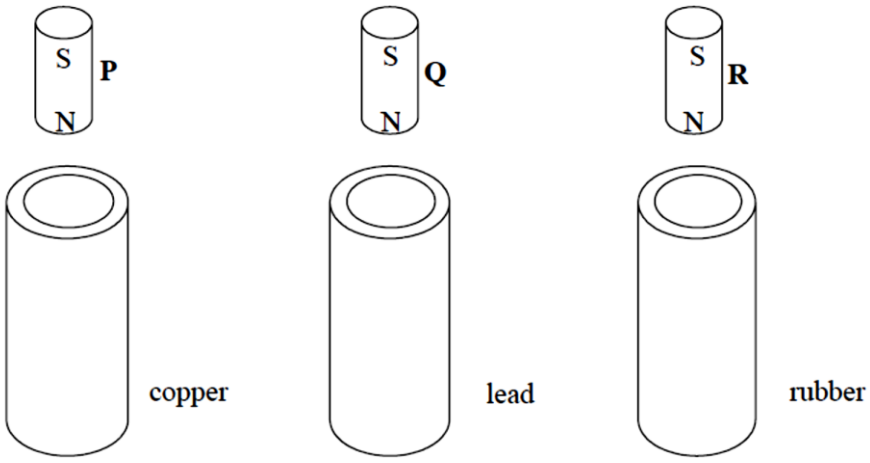
B



D



29



Three vertical tubes, made from copper, lead and rubber respectively, have identical dimensions. Identical, strong, cylindrical magnets P, Q and R are released simultaneously from the same distance above each tube. Because of electromagnetic effects, the magnets emerge from the bottom of the tubes at different times.

Which line, **A** to **D**, in the table shows the correct order in which they will emerge?

Resistivity of copper = $1.7 \times 10^{-8}\ \Omega$ m
Resistivity of lead = $22 \times 10^{-8}\ \Omega$ m
Resistivity of rubber = $50 \times 10^{13}\ \Omega$ m

	emerges first	emerges second	emerges third
A	P	Q	R
B	R	P	Q
C	R	Q	P
D	P	R	Q

30 Given that a sinusoidal current of root-mean-square value I dissipates power in a resistor at a maximum instantaneous rate of P, find the values for the mean current in the resistor and the mean power dissipated.

	Mean current	Mean power
A	$\frac{I}{\sqrt{2}}$	$\frac{P}{\sqrt{2}}$
B	I	$\frac{P}{2}$
C	0	$\frac{P}{\sqrt{2}}$
D	0	$\frac{P}{2}$

31 A generator produces a current of 60 A r.m.s. at a voltage of 120 V r.m.s. The voltage is stepped up to 4500 V r.m.s. by an ideal transformer and transmitted through a power line of total resistance 2.0 Ω.

What is the percentage power lost in the transmission line?

A 0.036% **B** 0.048% **C** 0.071% **D** 0.096%

32 In the photoelectric effect, light falling on a metal surface causes electrons to be ejected from the surface.

Which of the following statements is correct?

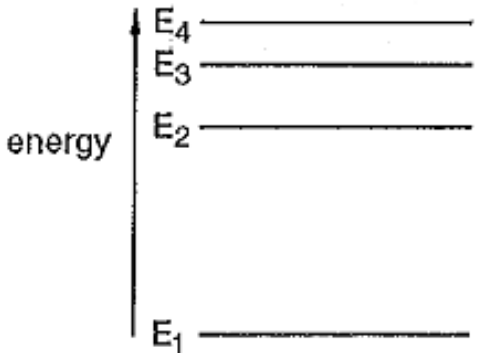
A The maximum energy of the electrons is independent of the type of metal.

B The maximum energy of the electrons is independent of the intensity of the incident light.

C The waves associated with the ejected electrons have the same wavelength as the incident light.

D Electrons are ejected only if the wavelength of the incident light is greater than some minimum value.

33 The diagram below represents in simplified form some of the lower energy levels of the hydrogen atom.



If the transition of an electron from E_4 to E_2 was associated with the emission of blue light, which one of the following transitions could be associated with the **absorption** of red light?

A E_2 to E_3

B E_3 to E_2

C E_1 to E_3

D E_3 to E_1

34 If the de Broglie waves associated with each of the following particles are to have the same wavelength, which particle must have the smallest velocity?

A proton

B alpha-particles

C $^{2}_{1}\mathrm{H}$ nucleus

D electron

35 A radar dish emits a pulse of 200 MHz electromagnetic waves of duration 9.3 ms. Determine the percentage uncertainty in the frequency of the waves.

A 9.5×10^{-1} **B** 3.3×10^{-4} **C** 4.3×10^{-6} **D** 3.7×10^{-10}

36 An electron is incident on a rectangular potential barrier with a kinetic energy of 2.0 eV. The barrier height is 6.0 eV and the reflection coefficient is 0.87. How wide is the barrier?

A 9.7×10^{-22} m

B 4.0×10^{-20} m

C 6.8×10^{-12} m

D 1.0×10^{-10} m

37 Why is laser light monochromatic?

A Stimulated emission causes the emitted photon and the incident photon to be of the same phase.

B The excited electrons are in a metastable state.

C Photons of the same energy as that of the incident photons are emitted when electrons transit down from a higher energy level.

D The system is in a state of population inversion.

38 Which of the following statements below on intrinsic semiconductors is true?

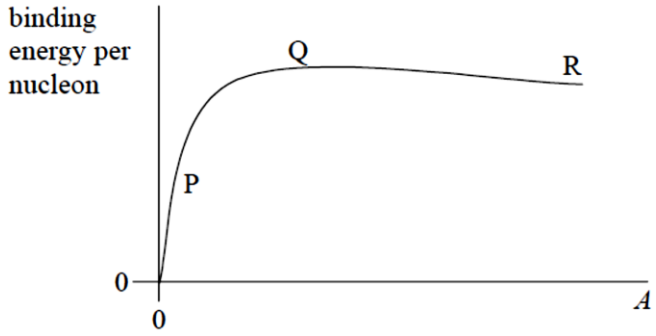
A The total current flow is the sum of both the ‘hole’ and ‘electron’ currents.

B The valence band is completely filled and the conduction band is partially filled.

C The valence band is completely filled and the conduction band is empty at room temperature.

D There are more electrons in the conduction band than there are holes in the valence band.

39 The graph 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 Energy is released in nuclear fission reactions from nuclei in region P.

B Nuclei in region Q are more stable than nuclei in region R.

C Nuclear fusion reactions bring nuclei closer to region Q.

D The binding energy per nucleon increases most significantly at lower nucleon numbers.

40 A radioactive source consists of 64×10^{12} atoms of nuclei *P* of half-life 2 days. Another source consists of 8×10^{12} atoms of nuclide *Q* of half-life 3 days. After how long will the number of active nuclei in the two sources be equal?

(Assume that the daughter nuclides of both *P* and *Q* are stable.)

A 6 days

B 9 days

C 12 days

D 18 days

END OF PAPER

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