VICTORIA JUNIOR COLLEGE
2007 JC2 PRELIMINARY EXAMINATIONS

PHYSICS **9745/01**
Higher 2

Paper 1 Multiple Choice

14/9/2007 **2.30 pm – 3.45 pm**
FRIDAY **(1 Hour 15 minutes)**

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name and NRIC 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. Please shade the ovals on the Answer Sheet correctly.

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 question set consists of a total of 16 printed pages.

Data

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

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,	$p = h\rho g$
gravitational potential,	$\phi = -\frac{GM}{r}$
displacement of particle in s.h.m.,	$x = x_o \sin \omega t$
velocity of particle in s.h.m.,	$v = v_o \cos \omega t$ $= \pm\omega\sqrt{(x_o^2 - x^2)}$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential,	$V = Q/4\pi\varepsilon_0 r$
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,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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1 The period of oscillation T of a piece of cardboard is found to be related to the distance h between the point of suspension and the centre of mass of the cardboard, by the formula:

$$T^2 ch = 4\pi^2 h^2 + cd$$

where c and d are constants. Which of the following are the correct units of c and d ?

	units of c	units of d
A	m^2	m s
B	s^2	m s^{-2}
C	m s^{-2}	m^2 s^{-1}
D	m s^{-2}	m s^2

2 Given that the quantities x , y and z are related by

$$xz = y^3$$

Calculate the percentage uncertainty in z if the maximum percentage uncertainties in x and y are 1 % and 3 % respectively.

A 2 % B 4 % C 8 % D 10 %

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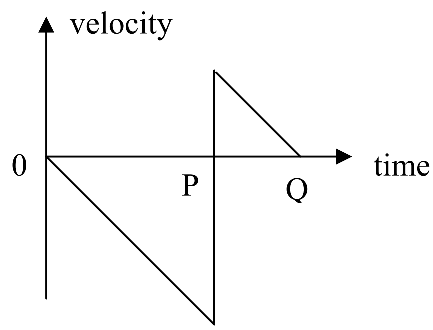
3 The graph represents the motion of a ball which is dropped to the ground and then bounces vertically.



The speed immediately after impact is half that immediately before impact. The time interval PQ is 0.40 s.

Assuming that the acceleration of free fall is 10 m s^{-2}, the maximum speed acquired by the ball just prior to impact with the ground is

A 25 m s^{-1} B 10 m s^{-1} C 8.0 m s^{-1} D 4.0 m s^{-1}

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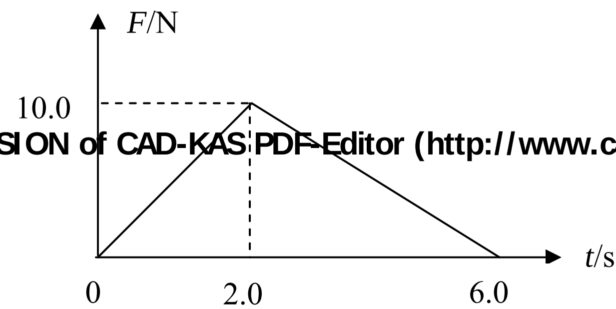
4 A tennis ball traveling at 4.0 m s^{-1} due east strikes a wall and bounces off at 3.0 m s^{-1} due north. What is the change in velocity of the tennis ball?

A 1.0 m s^{-1} due south
B 1.0 m s^{-1} S 53^O W
C 5.0 m s^{-1} N 53^O W
D 5.0 m s^{-1} S 53^O E

5 A man weighs 900 N standing on a scale in a stationary lift. If sometime later, the reading on the scale is 1200 N, the elevator must be moving with

A constant acceleration upward
B constant speed downward
C constant acceleration downward
D constant speed upward

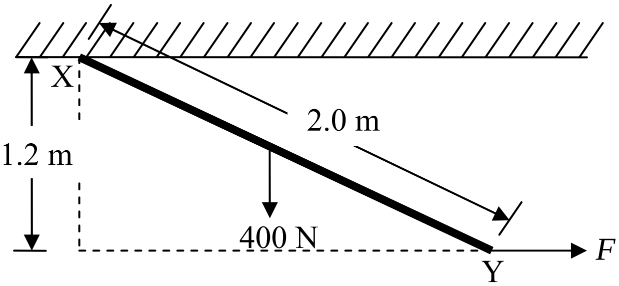
6 A force acts on a body initially at rest as shown below:



What is the momentum of the body after 6.0 s?

A 10 kg m s^{-1} B 20 kg m s^{-1}
C 30 kg m s^{-1} D 40 kg m s^{-1}

7 The figure shows a heavy uniform rod XY of length 2.0 m and weight 400 N. It is hinged at X and held to one side by a horizontal force F acting at Y.



What is the magnitude of F?

A 240 N B 270 N C 330 N D 670 N

8 On braking, 500 kJ of heat was produced when a vehicle of total mass 1600 kg was brought to rest on a level road. The speed of the vehicle just before the brakes were applied was

A 625 m s^{-1} B 0.625 m s^{-1} C 0.79 m s^{-1} D 25 m s^{-1}

9 The gravitational force on a textbook at the top of Pikes Peak (elevation 4230 m) is 40 N. What would be the approximate gravitational force on the same textbook if it were taken to twice the elevation?

A 5 N B 10 N C 20 N D 40 N

10 A rocket is launched from the surface of a planet with mass M and radius R. What is the minimum velocity the rocket must be given to completely escape from the planet's gravitational field?

A $\sqrt{\dfrac{2GM}{R^2}}$ B $\sqrt{\dfrac{2GM}{R}}$ C $\sqrt{\dfrac{GM}{R}}$ D $\sqrt{GM}$

11 Two identical particles P and Q are set to travel in a circular path of the same radius. P moves in a vertical circle and Q moves in a horizontal circle. Both move with the same uniform speed. Which one of the following statements concerning the magnitude of the *net force* acting on P and Q towards the center of the respective circular path is true?

A The net forces on P and Q are always equal in magnitude.
B Both the net forces on P and Q vary with time and are never equal in magnitude.
C Both the net forces on P and Q vary with time and are equal in magnitude periodically.
D The magnitude of the net force on P is always larger than that on Q.

12 The radius of the Earth's orbit around the Sun is approximately 1.5×10^{11} m, assuming a circular orbit. The speed of the Earth along its orbit is approximately

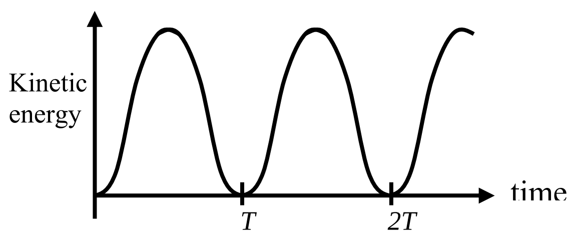
A $30\ \text{km s}^{-1}$ B $15\ \text{km s}^{-1}$ C $10\ \text{km s}^{-1}$ D $5\ \text{km s}^{-1}$

13 A sewing machine needle moves up and down through a **total** vertical distance of 2.0 cm. The frequency of the oscillation is 2.4 Hz. Assuming the motion is simple harmonic, calculate the maximum acceleration of the needle.

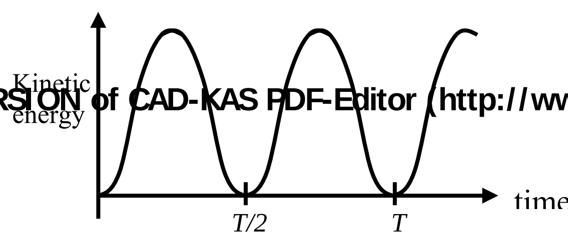
A $0.15\ \text{m s}^{-2}$ B $0.30\ \text{m s}^{-2}$ C $2.3\ \text{m s}^{-2}$ D $4.5\ \text{m s}^{-2}$

14 Which graph shows how the kinetic energy of an oscillating object varies with time in simple harmonic motion? The period of oscillation is *T*.

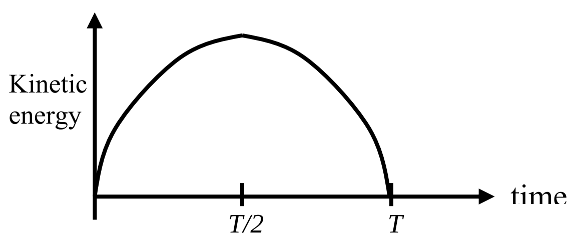
A



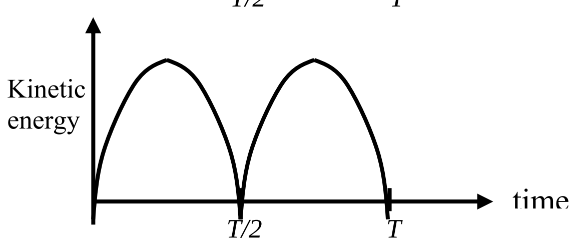
B



C



D



15 Energy E is supplied to water of mass m at 0 ^{0}C. Its temperature changes by $\Delta\theta$ in time Δt. If c and l_f are the specific heat capacity of water and specific latent of ice respectively, then

A $E = mc\dfrac{\Delta\theta}{\Delta t}$

B $E = ml_f$

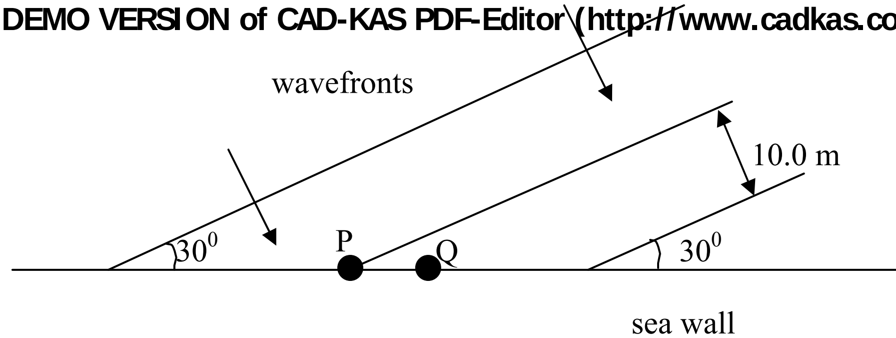
C $E = ml_f + mc\dfrac{\Delta\theta}{\Delta t}$

D $E = mc\Delta\theta$

16 The velocities of five gas molecules are: 100 m s^{-1}, – 400 m s^{-1}, 800 m s^{-1}, 1100 m s^{-1} and −1500 m s^{-1}. Calculate the root-mean-square speed of these molecules.

A 780 m s^{-1} B 20.0 m s^{-1}
C 924 m s^{-1} D 235 m s^{-1}

17 Parallel water waves of wavelength 10.0 m strike a straight sea wall. The wavefronts make an angle of 30^0 with the wall as shown. What is the phase difference between points P and Q which are 5.0 m apart along the wall?



A 45^0 B 90^0 C 180^0 D 270^0

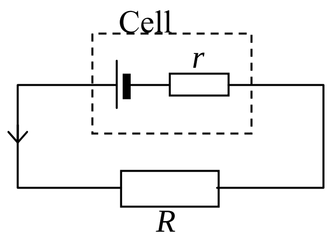
18 A boy blows gently across the top of a piece of glass tubing the low end of which is closed by his finger so that the tube gives its fundamental note of frequency, f. While blowing, he removes his finger from the lower end. The note he then hears will have a frequency of approximately

A ¼ f B ½ f C 2 f D 4 f

19 Light of wavelength 700 nm falls on a pair of slits, forming fringes 3.00 mm apart on a screen.
What would be the fringe spacing if the wavelength were 400 nm?

A 0.75 mm B 1.50 mm C 1.71 mm D 3.00 mm

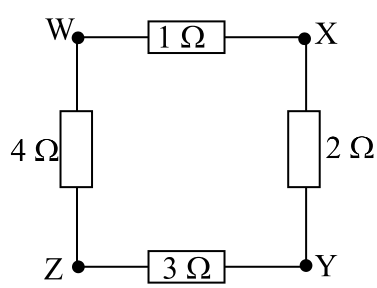
20 A cell of internal resistance *r* is connected to a load of resistance *R*.



The ratio $\dfrac{\text{power dissipated in } R}{\text{total power supplied by the emf source}}$ is

A $\dfrac{r}{R}$ B $\dfrac{R}{r}$ C $\dfrac{r}{R+r}$ D $\dfrac{R}{R+r}$

21 Four resistors are connected as shown.



Between which two terminals will the effective resistance be the ***maximum***?

A X and Z B W and X

C W and Y D W and Z

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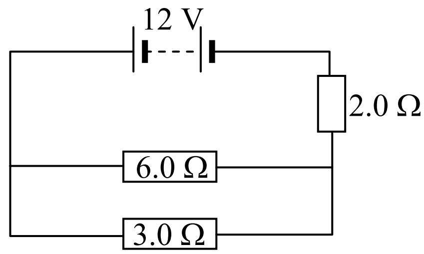
[Turn over

22 The diagram shows a circuit in which the battery has negligible internal resistance.



The power dissipated in the 6.0 Ω resistor is

A 54.0 W B 36.0 W C 18.0 W D 6.0 W

23 An electron is emitted from an electron gun with a speed of 3.0×10^6 m s^{-1}. It moves towards a metal grid which is positioned at 10.0 cm away from the gun. The grid is maintained at a potential of +100 V with respect to the electron gun. What is the speed of the electron as it reaches the grid?

A 6.6×10^6 m s^{-1} B 5.9×10^6 m s^{-1}

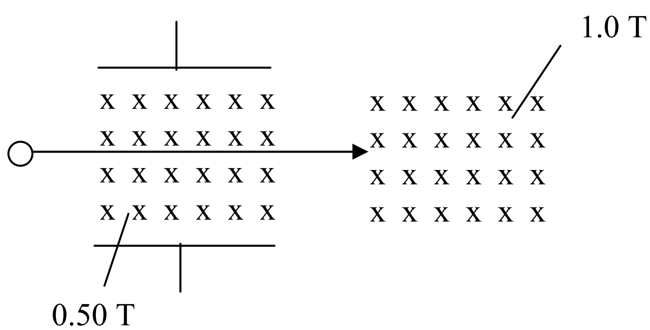
C 4.2×10^6 m s^{-1} D 3.9×10^6 m s^{-1}

24 An oil drop of mass m and charge $+q$ is held stationary in an electric field of strength E. Which of the following equations is correct for the magnitude of its charge?

A $q = mgE$ B $q = \dfrac{mg}{E}$

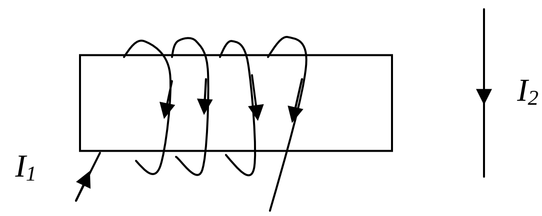
C $q = \dfrac{E}{mg}$ D $q = \dfrac{m}{gE}$

25 An electron enters a uniform electric field of magnitude 1.5×10^7 V m^{-1} between two parallel plates. There is also a magnetic field of magnitude 0.50 T in this region, which is perpendicular to the electric field as shown. The electron goes past this region undeflected and enters a second magnetic field of magnitude 1.0 T. The second field is parallel to the first field. What is the radius of the path of the electron in the second field?



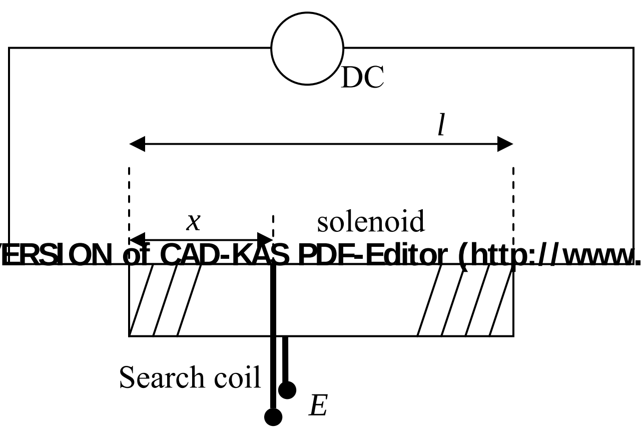
A 8.5×10^{-5} m B 1.7×10^{-4} m
C 3.4×10^{-4} m D 0.31 m

26 A current I_1 is passed into a solenoid as shown. A suspended light wire carrying a current I_2 is placed near one end of the solenoid. When a soft iron is inserted into the solenoid, what is the direction of motion of the wire?

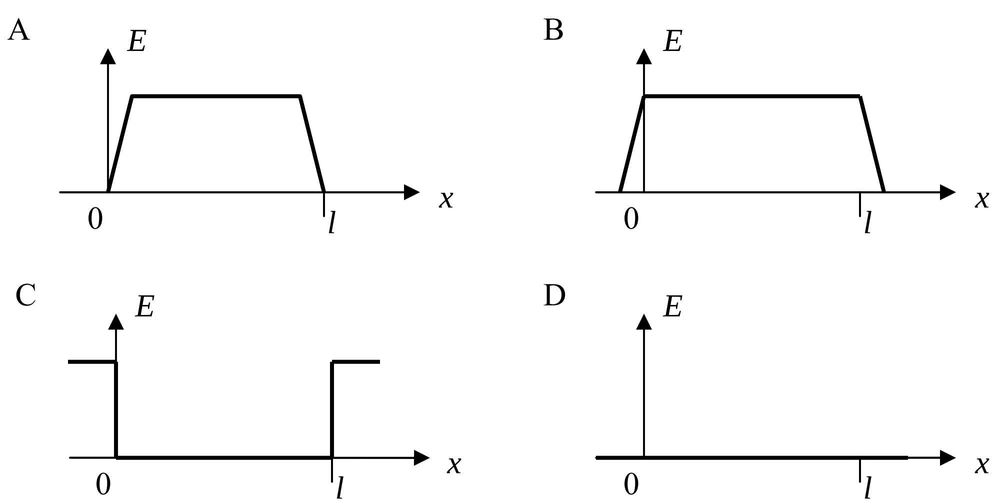


A to the left B to the right
C into the page D out of the page

27 A solenoid, of length l closely and uniformly wound as shown, carries a steady direct current. A search coil is placed at different positions along the solenoid.

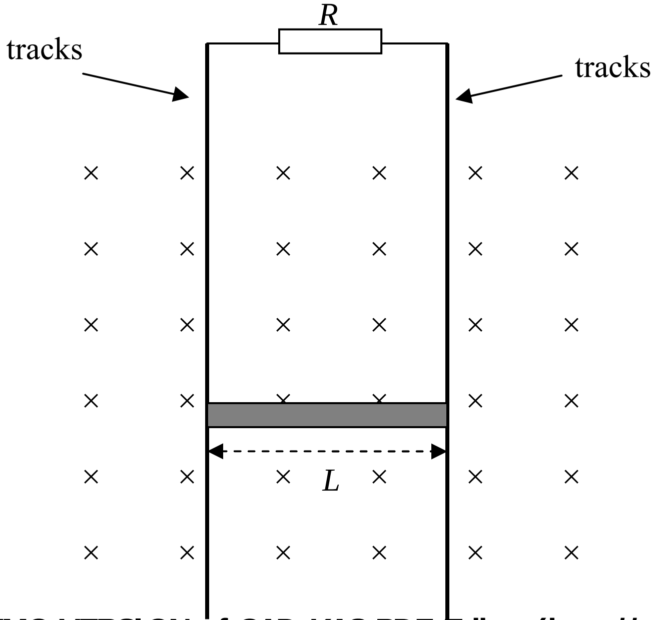


Which one of the following graphs best shows how the amplitude of the emf E induced in the search coil varies with its position?



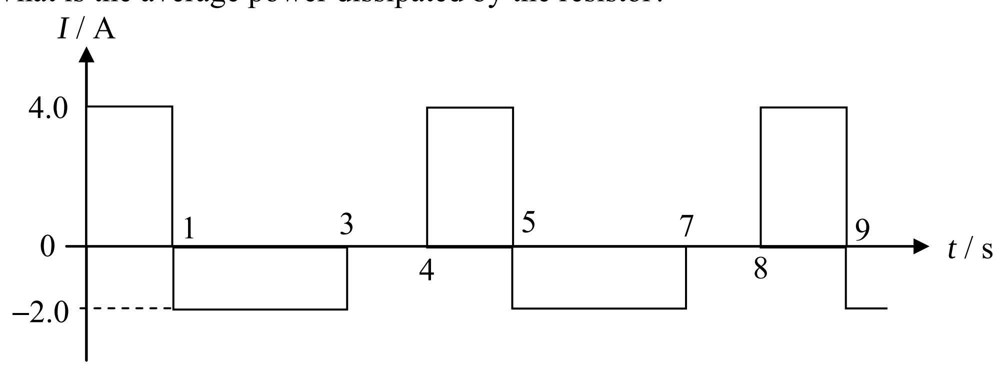
[Turn over

28 A metal rod of mass m and length L slides vertically on two frictionless metal tracks with negligible electrical resistance, and along a plane that is perpendicular to a region of magnetic field strength B as shown. A constant force of $2mg$ is applied upwards on the metal rod and it finally reaches terminal velocity. What is the maximum power dissipated in the resistor?



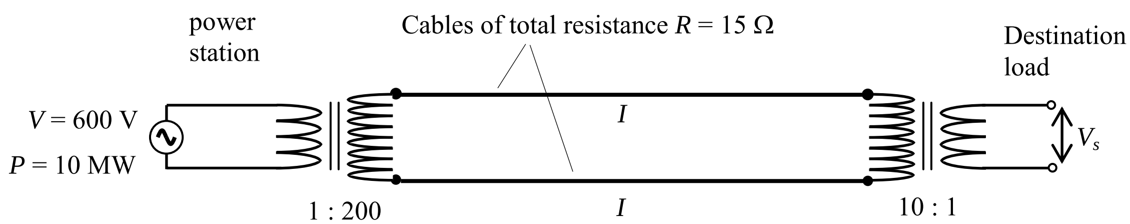
A $R[mg/(BL)]^2$ B $R[2mg/(BL)]^2$
C $R[3mg/(BL)]^2$ D $R[4mg/(BL)]^2$

29 An alternating current with a rectangular waveform flows through a 11 Ω resistor. What is the average power dissipated by the resistor?



A 0 W B 44 W C 66 W D 88 W

30 A 10 MW nuclear power station produces electrical power at 600 V. It uses a step-up transformer with a turns ratio of 1: 200 to increase the voltage before transmitting it over long-distance cables of total resistance 15 Ω. At the destination end of the cables, a second transformer with a turns ratio of 10 : 1 steps down the voltage. Calculate the power lost as heat in the cables.



A 5.0×10^4 W B 1.0×10^5 W
C 1.0×10^6 W D 9.6×10^8 W

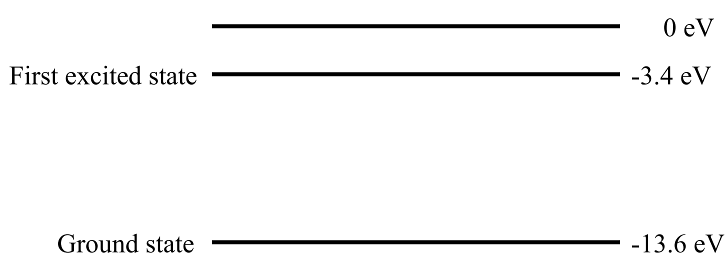
31 The frequency of a 5 MeV γ-ray is

A greater than 1.0×10^{21} Hz
B less than 1.0×10^{21} Hz
C greater than 2.0×10^{-13} Hz
D less than 2.0×10^{-13} Hz

32 A metal surface in an evacuated tube is illuminated with monochromatic light causing the emission of photoelectrons which are collected at an adjacent electrode.
If the experiment were to be repeated with light of half the intensity but the same wavelength, how would the photocurrent I and stopping potential V be affected?

A I unchanged, V doubled
B I halved, V unchanged
C I halved, V halved
D I halved, V doubled

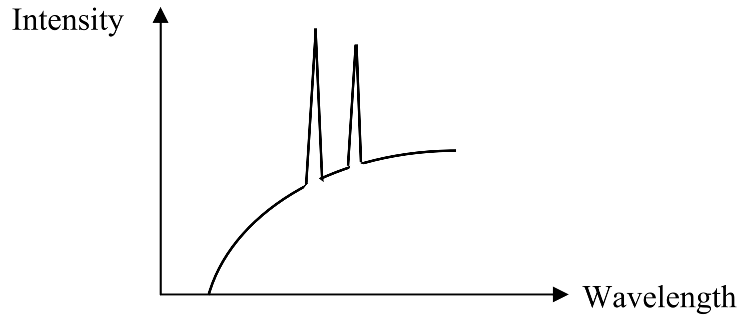
33 The diagram is a simplified energy level diagram for atomic hydrogen. A free electron with kinetic energy 12 eV collides with an atom of hydrogen and causes it to be raised to its first excited state. Find the wavelength of the photon emitted when the atom returns to its ground state.



A 91 nm B 103 nm C 120 nm D 690 nm

[Turn over

34 The graph shows the spectrum of X-rays emitted from an X-ray tube. Which of the following statements is/are correct?



1 The wavelengths at which the peaks appear are independent of the voltage across the tube.

2 The minimum (cut-off) wavelength is independent of the atomic number of the target in the X-ray tube.

3 The continuous part of the spectrum is due to the very high temperature attained by the target in the X-ray tube.

A 1 only B 2 only C 1 & 3 only D 1 & 2 only

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35 At absolute zero temperature, the kinetic energy of the harmonic oscillator is not zero. This is the expected result of

A the photoelectric effect
B the particulate nature of the oscillator
C the Heisenberg uncertainty principle
D the quantum tunneling effect

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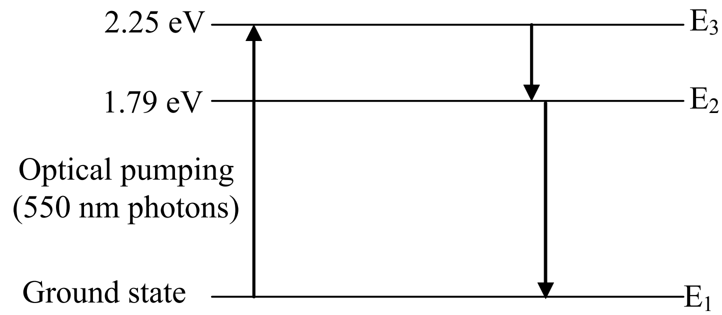
36 In a ruby laser, light of wavelength 550 nm from a xenon flash lamp is used to excite the chromium (Cr) atoms in the ruby from ground state E_1 to state E_3. In subsequent de-excitations, laser light is emitted. Which of the following statements regarding this laser is **incorrect**?



A E_3 cannot be the metastable state because, if it is, then there will be no net production of light when equilibrium is reached, since stimulated absorption and stimulated emission will then occur at the same rate because the numbers of electrons in E_3 and E_1 will be the same at steady state.

B E_3 is the metastable state because, having a longer lifetime than a normal excited state, the metastable state allows the accumulation of excited electrons, resulting in population inversion and net light production.

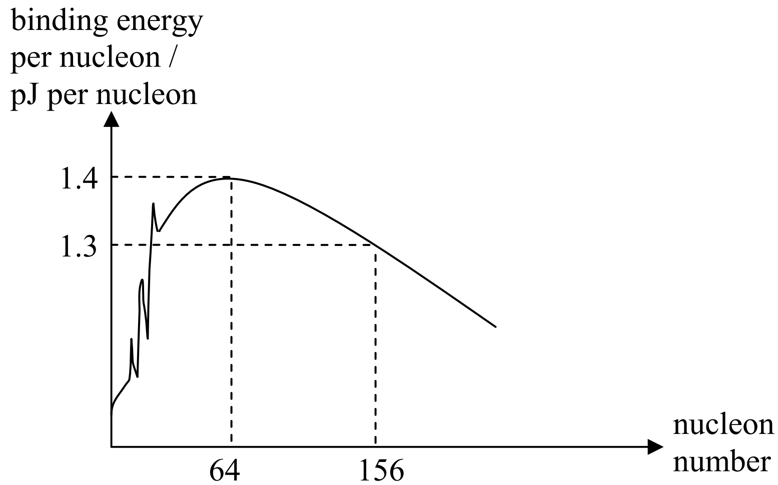
C E_2 is the metastable state because it is not subject to stimulated emission caused by the 550 nm photons used in optical pumping, and so allows the accumulation of excited electrons to achieve population inversion.

D The transition from state E_2 to E_1 produces the laser light.

37 In a nuclear reaction, energy equivalent to 10^{-11} kg of matter is released. The energy released is approximately

A 4.5 μJ
B 9.0 μJ
C 900 kJ
D 450 kJ

38 The graph below shows how the binding energy per nucleon varies with the nucleon number for naturally occurring nuclides.



What is the total binding energy of the nuclide ${}^{156}_{64}Gd$?

A 83 pJ B 90 pJ C 203 pJ D 218 pJ

39 A radioactive decay series, starting with thorium ${}^{232}_{90}Th$, involves the emission, in turn, of the following: alpha, beta, beta, gamma, alpha. What is the final product of this series?

A ${}^{230}_{82}Pb$ B ${}^{224}_{88}Ra$ C ${}^{226}_{86}Rn$ D ${}^{225}_{87}Fr$

40 The half-life of a certain radioactive element is such that $\frac{7}{8}$ of a given quantity decays in 12 days. What fraction remains undecayed after 24 days?

A $\frac{1}{128}$ B $\frac{1}{64}$ C $\frac{1}{32}$ D $\frac{1}{16}$

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