# RAFFLES INSTITUTION
2009 Preliminary Examination

**PHYSICS**
**Higher 1**

**8866 / 01**

Paper 1 Multiple Choice

**25 September 2009**
**1 hour**

Additional Materials: OMR form
Soft clean eraser
Soft pencil (type B or HB is recommended)

**READ THESE INSTRUCTIONS FIRST**

**Do not open this booklet until you are told to do so.**

Fill in your particulars on the OMR form.

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 OMR form.

**Read the instructions on the OMR form 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.

This booklet consists of **13** printed pages including the cover page.

## Data

| | |
|---|---|
| speed of light in free space, | $c = 3.00 \times 10^{8}$ m s$^{-1}$ |
| 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 |
| 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, | $p = \rho gh$ |
| resistors in series, | $R = R_1 + R_2 + \ldots$ |
| resistors in parallel, | $1/R = 1/R_1 + 1/R_2 + \ldots$ |

**1** Estimate the kinetic energy of an Olympic gold medallist running the 100 m race.

**A** 0.3 kJ **B** 3 kJ **C** 30 kJ **D** 300 kJ

**2** In the following equation, $P$ is pressure, $h$ is height, $x$ is density and $g$ is acceleration:

$$\frac{1}{2}xy^2 + xhg + P = \text{constant}.$$

What is the base unit of $y$?

**A** $\text{m s}^{-1}$

**B** $\text{m}^2\,\text{s}^{-2}$

**C** $\text{N kg}^{-1}\,\text{m}$

**D** $\text{N}^{1/2}\,\text{kg}^{-1/2}\,\text{m}^{1/2}$

**3** A student uses a pair of vernier callipers to measure the dimensions of a cylinder to the nearest tenth of a millimetre. Its diameter is 15.4 mm and its height is 9.7 mm. Which of the following best expresses the volume of the cylinder?

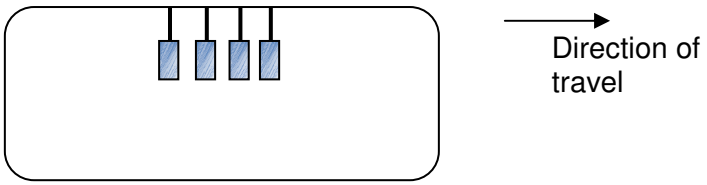
**A** $1.807 \times 10^3\ \text{mm}^3$

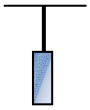
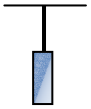
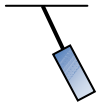
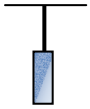
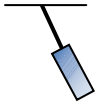
**B** $1.81 \times 10^3\ \text{mm}^3$

**C** $1.8 \times 10^3\ \text{mm}^3$

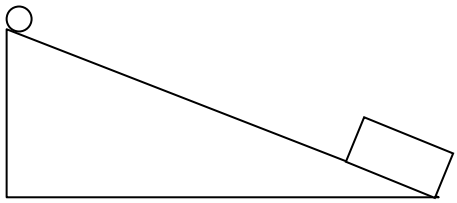
**D** $2 \times 10^3\ \text{mm}^3$

**4** In the MRT, there are hanging grips for passengers to hold on to when they are standing. In between the stations, the MRT is travelling at constant velocity and decelerates to stop at the station. Which of the following shows the position of the hanging grips when the MRT is travelling with constant velocity and when it is decelerating?



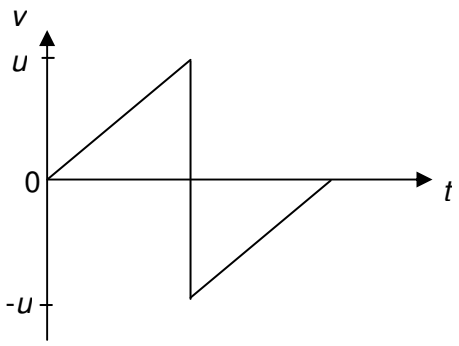

| | Moving at Constant Velocity | Decelerating |
|---|---|---|
| **A** |  |  |
| **B** |  |  |
| **C** |  |  |
| **D** |  |  |

**5** A marble is placed at the top of a rough slope that has a block fixed rigidly to its lower end, as shown below.

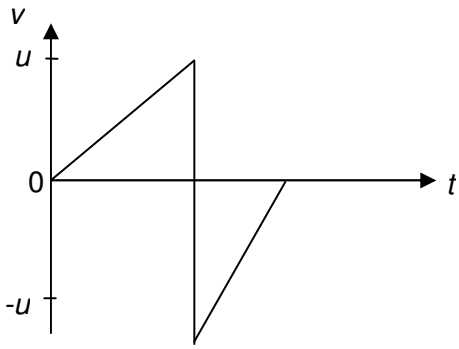


The marble is released from the top of the incline. It rolls down the slope, hits the block and moves up the slope till it comes to a momentary rest. If the frictional force on the marble is constant in magnitude, which of the following graphs correctly shows the variation with time *t* of the velocity *v* of the marble on the slope?

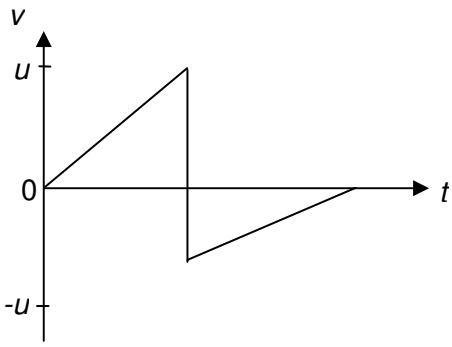
**A**



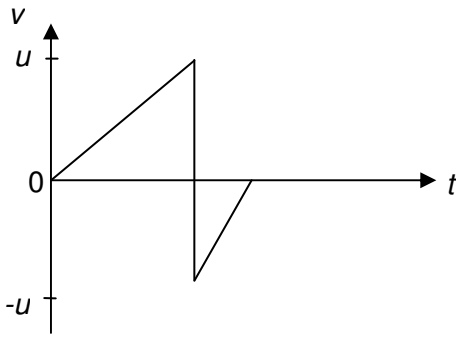

**B**



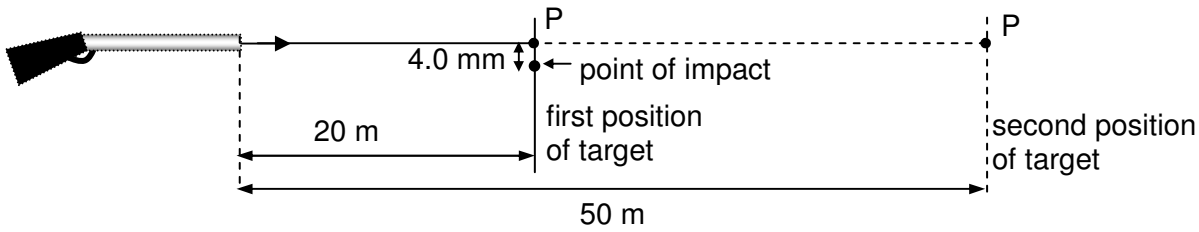

**C**




**D**



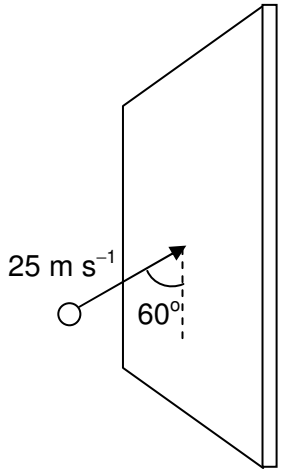

**6** When a rifle is fired horizontally at a target P on a screen at a range of 20 m, the bullet strikes the screen at a point 4.0 mm below P. The screen is now moved to a distance of 50 m and the rifle again fire horizontally at P in its new position (see diagram below).




Assuming that air resistance may be neglected, what is the new distance below P at which the screen would now be struck?

**A** 6.3 mm **B** 10 mm **C** 16 mm **D** 25 mm

**7** A ball of mass 0.060 kg and speed 25 m $s^{-1}$ strikes a smooth, vertical wall at an angle of 60° to the wall as shown below.




If the collision is elastic and the time of duration of the collision is 0.020 s, what is the magnitude and direction of the force exerted by the wall on the ball?

| | Magnitude | Direction |
|---|---|---|
| **A** | 130 N | normal to the wall and away from it |
| **B** | 130 N | opposite in direction to the initial velocity |
| **C** | 150 N | normal to the wall and away from it |
| **D** | 150 N | opposite in direction to the initial velocity |

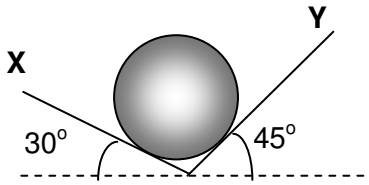
**8** Tarzan, whose mass is 80 kg, swings in a circular arc from a 3.0 m vine that is horizontal when he starts. At the bottom of his trajectory, he picks up 60 kg Jane in a completely inelastic collision. What is the height of the highest tree limb they can reach on their upward swing?

**A** 0.75 m **B** 0.98 m **C** 1.7 m **D** 3.0 m

**9** A small block of wood, of density 400 kg $m^{-3}$, is held fully submerged in water. What is the initial acceleration of the block towards the surface when the block is released? (Take the density of water to be 1000 kg $m^{-3}$.)

**A** 1.5 m $s^{-2}$ **B** 9.8 m $s^{-2}$ **C** 15 m $s^{-2}$ **D** 25 m $s^{-2}$

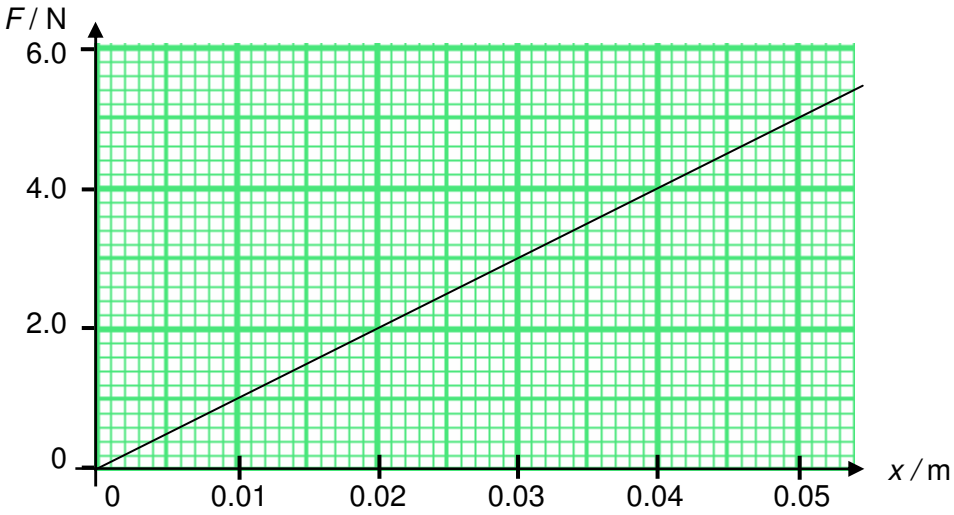
**10** A bowling ball rests against the frictionless walls, **X** and **Y**, of a groove as shown in the diagram below.




What is the ratio of the reaction force of wall **X** to that of wall **Y**?

**A** 0.71 **B** 0.82 **C** 1.0 **D** 1.4

**11** The graph shows the relationship between load *F* and extension *x* for a certain spring.

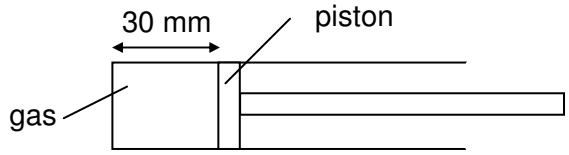



A load of 3.0 N is placed on the spring.

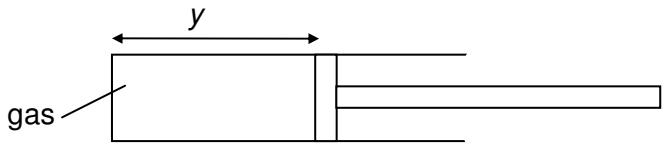
What additional elastic potential energy will be stored in the spring if it is then extended a further 0.01 m?

**A** 0.005 J **B** 0.030 J **C** 0.035 J **D** 0.080 J

**12** A gas is enclosed in a cylinder by a frictionless piston of cross-sectional area $3.0 \times 10^{-3}$ m$^2$. When atmospheric pressure is $1.01 \times 10^5$ N m$^{-2}$, the piston settles 30 mm from the end of the cylinder as shown.




The gas is then heated and it expands by pushing the piston against atmospheric pressure until the piston is is at a distance *y* from the end of the cylinder as shown.




If the work done by the gas during this expansion is 15 J, what is the value of *y* ?

**A** 50 mm **B** 60 mm **C** 80 mm **D** 100 mm

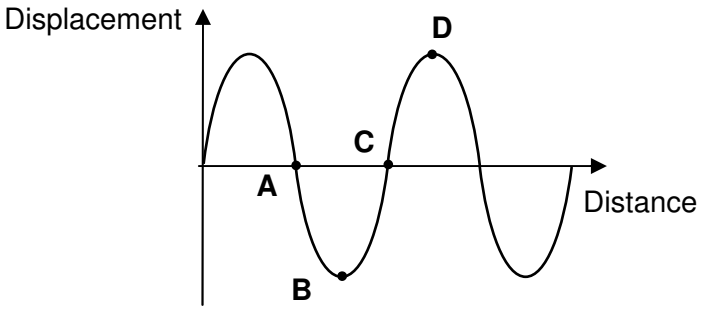
**13** A stone of mass 0.40 kg is projected horizontally at a speed of 6.0 m s$^{-1}$ from the top of a wall, 5.0 m above the surrounding ground. When it arrives at the ground its speed is 10 m s$^{-1}$. How much work is done by the stone against air resistance in falling through the air?

**A** 6.8 J **B** 7.6 J **C** 13 J **D** 20 J

**14** During a human heart beat, 20 g of blood are pushed into the main arteries. This blood is accelerated from a speed of 0.20 m s$^{-1}$ to 0.34 m s$^{-1}$. For a heart pulsing at 70 beats per minute, the average power of the heart pump is

**A** 0.012 mW **B** 0.23 mW **C** 0.88 mW **D** 1.8 mW

**15** A sound wave travelling towards the right through air causes the air molecules to be displaced from their original positions. The graph below shows the variation with distance of the displacement of air molecules at a particular instant of time.




Taking the displacement towards the right as positive, at which point is the pressure maximum?

**16** A wave of frequency 500 Hz travels at a speed of 350 m $s^{-1}$. What is the least separation between two points which are oscillating $60^0$ out of phase?

**A** 0.059 m **B** 0.12 m **C** 0.24 m **D** 1.2 m

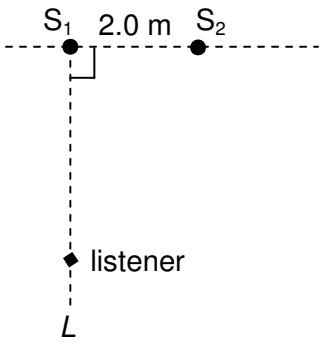
**17** A point source of sound emits energy uniformly in all directions at a constant rate and a detector placed 3.0 m from the source measures an intensity of 3.0 W $m^{-2}$. The power of the source is then doubled. What intensity would the detector measure if it is placed at a distance 5.0 m from the source?

**A** 2.2 W $m^{-2}$ **B** 2.5 W $m^{-2}$ **C** 3.6 W $m^{-2}$ **D** 4.3 W $m^{-2}$

**18** By blowing across the mouth of a glass bottle, the air column in the bottle can be made to vibrate and produce a tone. In order to tune the bottle and use it as a musical instrument, the fundamental frequency of the bottle must be 440 Hz. The bottle is 0.450 m tall and the speed of sound is 340 m $s^{-1.}$ How high should the bottle be filled with water?

**A** 0.064 m **B** 0.193 m **C** 0.257 m **D** 0.386 m

**19** The diagram below shows two speakers, $S_1$ and $S_2$, of a stereo system connected to the same source, which produces sound of wavelength 2.0 m. The speakers are 2.0 m apart.




How far back from $S_1$ must a listener move, along the line $S_1L$, until he first hears a minimum in sound intensity?

**A** 0.5 m **B** 1.0 m **C** 1.5 m **D** 2.0 m

**20** In a Young's double slit experiment, a small detector measures an intensity of illumination of $\mathbf{I}$ units at the centre of the fringe pattern. What will be the measured intensity if one of the two (identical) slits is now covered?

**A** $\frac{1}{4}\mathbf{I}$ **B** $\frac{1}{2}\mathbf{I}$ **C** $\mathbf{I}$ **D** $2\mathbf{I}$

**21** A high potential difference is applied between the electrodes of a hydrogen discharge tube so that the gas is ionised. Electrons then move towards the positive electrode and protons towards the negative electrode. In each second, $6.0 \times 10^{17}$ electrons and $3.0 \times 10^{17}$ protons pass a cross-section of the tube. The current flowing in the discharge tube is

**A** 0.048 A **B** 0.096 A **C** 0.14 A **D** 0.19 A

**22** A cell of emf $E$ and internal resistance $r$ is connected to a variable resistor $R$ as shown in Figure (a). Figure (b) shows the variation with ammeter reading $I$ of the voltmeter reading $V$ as $R$ is varied.

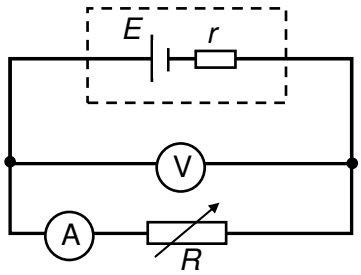



Figure (a)

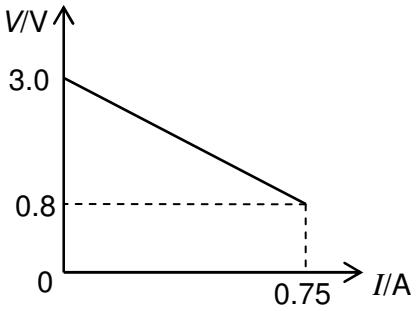
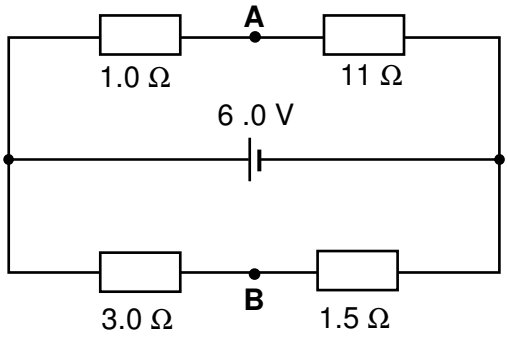



Figure (b)

Assuming that both the voltmeter and ammeter are ideal, the internal resistance $r$ of the cell is

**A** 1.1 Ω **B** 2.9 Ω **C** 4.0 Ω **D** 5.1 Ω

**23** What is the potential difference between the points **A** and **B** in the following circuit?




**A** 0 V **B** 3.5 V **C** 4.5 V **D** 7.5 V

**24** Two identical heaters of X volt and W watt rating are to be connected to a dc source of X volt, first in series and then in parallel. Which one of the following statements is correct?

**A** The total power drawn in each case is the same.

**B** There is more current drawn from the source in the series connection.

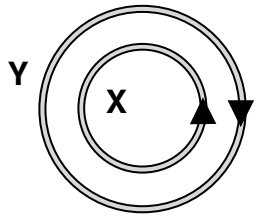
**C** The total power drawn is 2W in the series connection.

**D** The power drawn is higher in the parallel connection.

**25** The magnetic flux density at the centre of a flat circular coil is given by the equation

$$B = \frac{\mu_o NI}{2r}$$

Two such coils, **X** and **Y**, each with 50 turns, are arranged as shown in the diagram.




**X** has radius 0.060 m and carries a current of 1.5 A in the anti-clockwise direction, **Y** has radius 0.12 m and carries a current of 1.0 A in the clockwise direction.

What is the magnitude and direction of the total magnetic flux density at the centre of the coils?

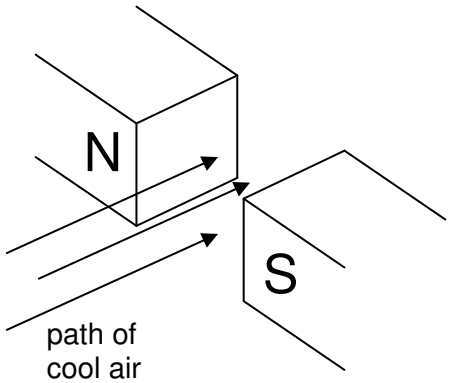
**A** $417\mu_o$ out of the page

**B** $417\mu_o$ into the page

**C** $833\mu_o$ out of the page

**D** $833\mu_o$ into the page

**26** Cool air from an air ventilator contains many positively charged ions. The motion of these ions constitutes an electric current.




When the cool air is directed between the poles of a strong magnet as shown, the ions are deflected

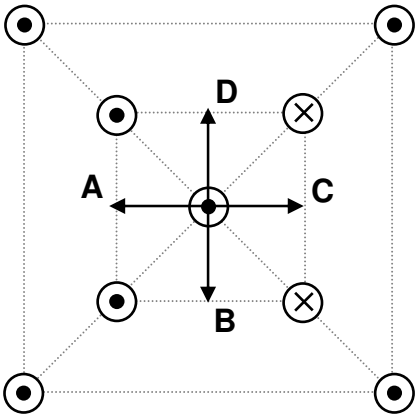
**A** upwards.

**B** downwards.

**C** towards the north pole.

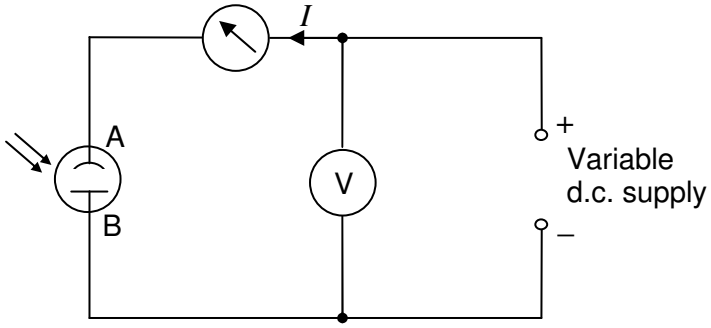
**D** towards the south pole.

**27** Nine long vertical wires carry equal currents into or out of the page in the directions shown in the diagram.

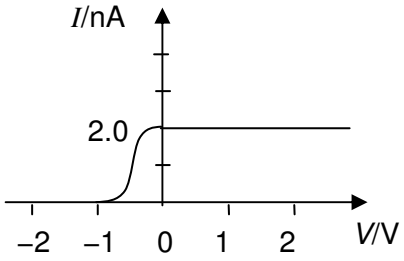



Which arrow best shows the direction of the resultant force on the wire in the centre?

**28** Two metal electrodes A and B are sealed into an evacuated glass envelope and a potential difference *V*, measured by the voltmeter, is applied between them as shown.




B is illuminated with monochromatic light of wavelength 380 nm. The diagram below shows the variation with the potential difference *V* of the current *I* in the circuit.




What is the work function of B?

**A** 1.0 eV **B** 2.3 eV **C** 3.3 eV **D** 4.3 eV

**29** Which of the following provides evidence for the wave nature of particles?

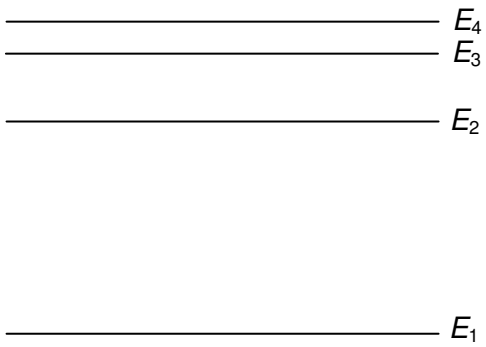
**A** Diffraction of light

**B** Photoelectric effect

**C** Cathode-ray tube

**D** Electron diffraction

**30** The diagram below, drawn to scale, shows the first four energy levels of an electron in a certain atom.




The transition from $E_3$ to $E_1$ produces a green line. Which transition could give rise to a red line?

**A** $E_4$ to $E_1$

**B** $E_4$ to $E_2$

**C** $E_3$ to $E_2$

**D** $E_2$ to $E_1$

********** **END OF PAPER** **********