IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

PHYSICS
HIGHER LEVEL
PAPER 1

Friday 5 November 2004 (afternoon)

1 hour

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.

1. Which of the following gives the approximate ratio of the separation of the molecules in water and in steam at atmospheric pressure?

	Water : Steam
A.	1 : 1
B.	1 : 10
C.	1 : 100
D.	1 : 1000

2. Which of the following is the best estimate, to one significant digit, of the quantity shown below?

$$\frac{\pi \times 8.1}{\sqrt{(15.9)}}$$

A.　1.5

B.　2.0

C.　5.8

D.　6.0

3. A student measures two lengths as follows:

$T = 10.0 \pm 0.1$ cm
$S = 20.0 \pm 0.1$ cm.

The student calculates:

F_T, the fractional uncertainty in T
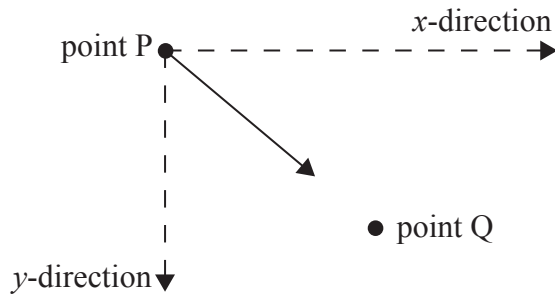F_S, the fractional uncertainty in S
F_{T-S}, the fractional uncertainty in $(T - S)$
F_{T+S}, the fractional uncertainty in $(T + S)$.

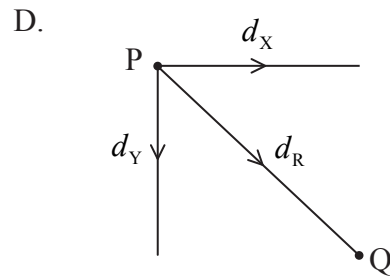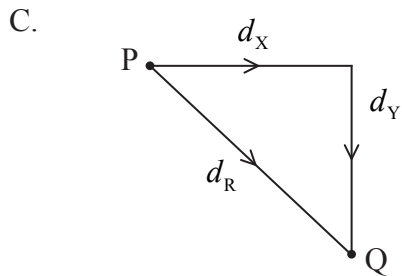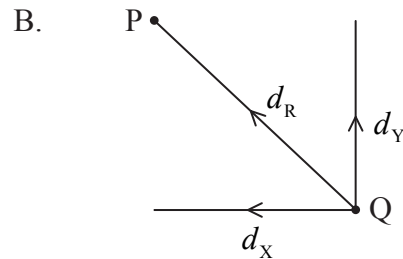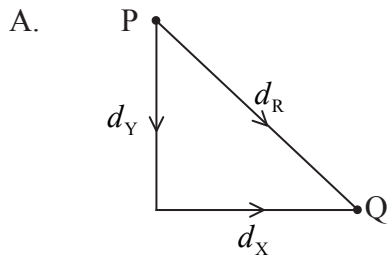Which of these uncertainties has the **largest** magnitude?

A.　F_T

B.　F_S

C.　F_{T-S}

D.　F_{T+S}

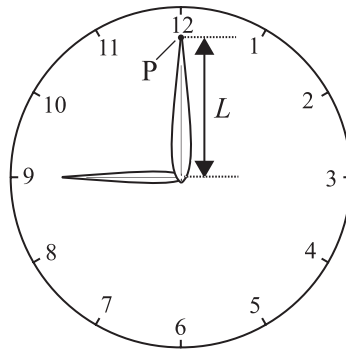**4.**   A student moves between two points P and Q as shown below.

The displacement from P in the x-direction is d_X. The displacement from P in the y-direction is d_Y. The resultant displacement from P is d_R.

Which of the following diagrams shows the **three** displacements from point P?

A.

B.

C.

D.

**5.** The minute hand of a clock hung on a vertical wall has length L.

The minute hand is observed at the time shown above and then again, 30 minutes later.

What is the displacement of, and the distance moved by, the end P of the minute hand during this time interval?

	displacement	distance moved
A.	$2L$ vertically downwards	πL
B.	$2L$ vertically upwards	πL
C.	$2L$ vertically downwards	$2L$
D.	$2L$ vertically upwards	$2L$

6.   The variation with time of the vertical speed of a ball falling in air is shown below.
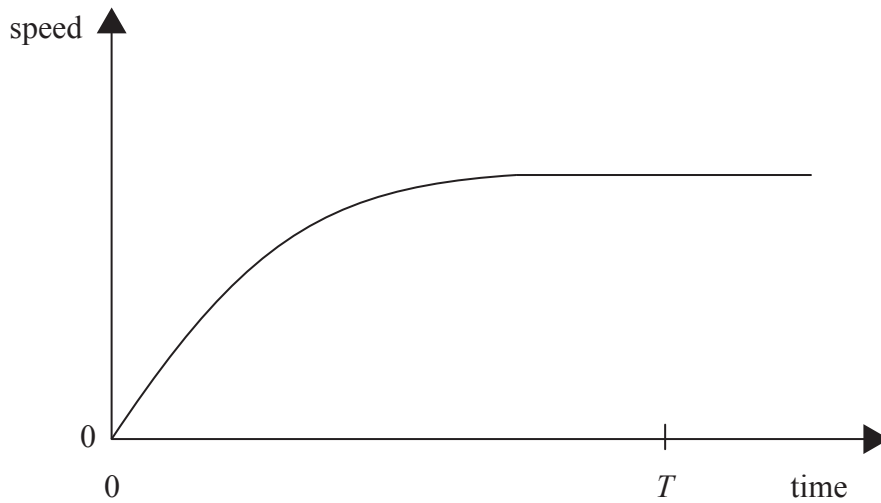
During the time from 0 to T, the ball gains kinetic energy and loses gravitational potential energy ΔE_p. Which of the following statements is true?

A. ΔE_p is equal to the gain in kinetic energy.

B. ΔE_p is greater than the gain in kinetic energy.

C. ΔE_p is equal to the work done against air resistance.

D. ΔE_p is less than the work done against air resistance.

7.   Two blocks having different masses slide down a frictionless slope.

Which of the following correctly compares the accelerating force acting on each block and also the accelerations of the blocks down the slope?

	Accelerating force	Acceleration
A.	Equal	Equal
B.	Equal	Different
C.	Different	Equal
D.	Different	Different

Turn over

8. The inertial mass of an object defines the property that

  A. keeps the object moving when no force acts on it.

  B. is the ratio of resultant force acting on the object and its acceleration.

  C. gives a measure of the amount of substance in the object.

  D. is inversely proportional to the acceleration of the object.

**9.** A stone on a string is moving in a circle as shown below.
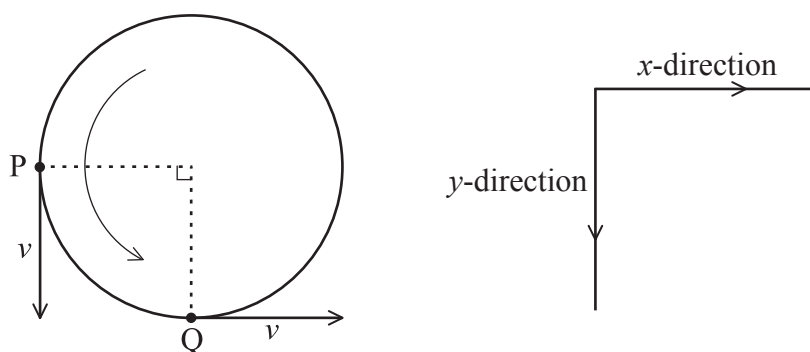
At point P, the stone of mass m has speed v in the y-direction. A quarter of a revolution later, the stone at point Q has speed v in the x-direction.

What is the change, in the y-direction **only**, of the magnitude of the momentum of the stone?

  A. zero

  B. mv

  C. $\sqrt{2}mv$

  D. $2mv$

10. Which of the following involves a change in the **total** energy of the objects?

  A. Some ice and water as the ice melts at constant temperature.

  B. An electron accelerated by a magnetic field.

  C. A satellite in a circular orbit round the Earth.

  D. A stone falling in a vacuum towards the Earth's surface.

11. A ball is thrown horizontally from the top of a cliff. Air resistance is negligible. Which of the following diagrams best represents the subsequent path of the ball?

A.

B.

C.

D.
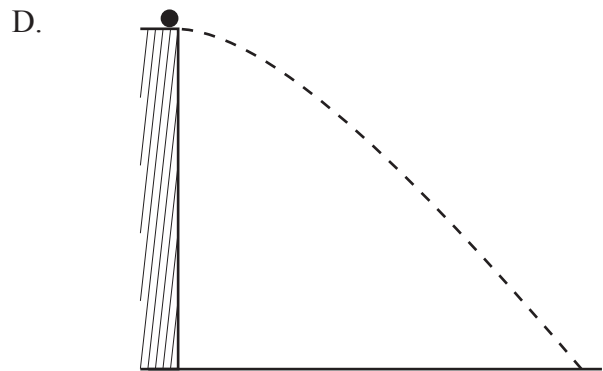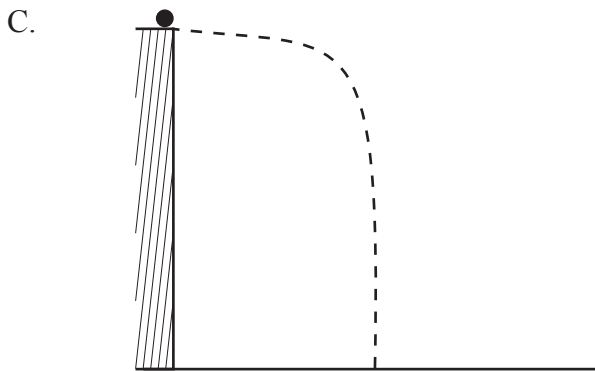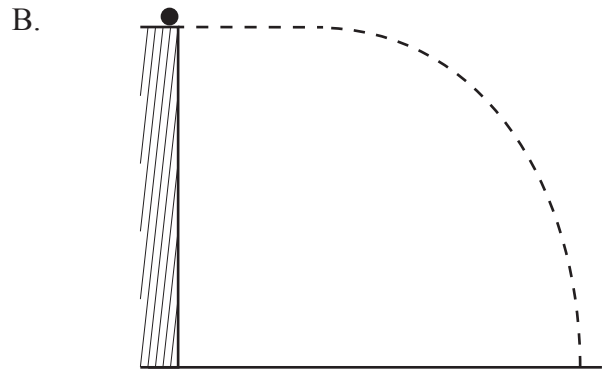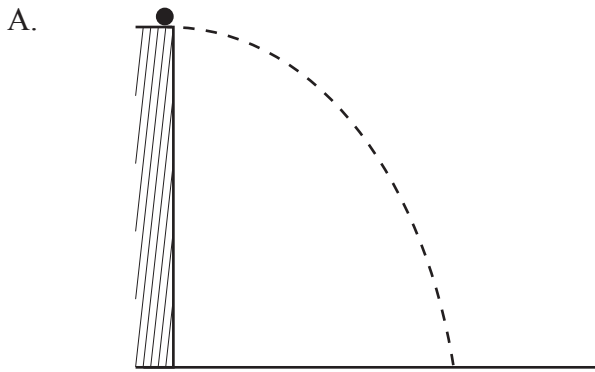
12. The Earth is distance R_M from the Moon and distance R_S from the Sun. The ratio

$$\frac{\text{gravitational field strength at the Earth due to the Moon}}{\text{gravitational field strength at the Earth due to the Sun}}$$
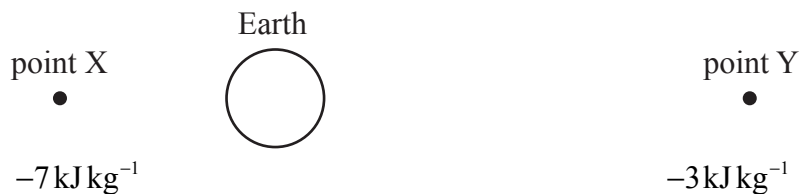
is proportional to which of the following?

A. $\dfrac{R_M{}^2}{R_S{}^2}$

B. $\dfrac{R_M}{R_S}$

C. $\dfrac{R_S{}^2}{R_M{}^2}$

D. $\dfrac{R_S}{R_M}$

13. The gravitational potential at point X due to the Earth is $-7\,\text{kJ}\,\text{kg}^{-1}$. At point Y, the gravitational potential is $-3\,\text{kJ}\,\text{kg}^{-1}$.

Earth

point X   point Y
•   •

$-7\,\text{kJ}\,\text{kg}^{-1}$ $-3\,\text{kJ}\,\text{kg}^{-1}$

The change in gravitational potential energy of a mass of 4 kg when it is moved from point X to point Y is

A.   4 kJ.

B.   10 kJ.

C.   16 kJ.

D.   40 kJ.

14. Which of the following expressions correctly relates the radius R of the circular orbit of a planet round a star to the period T of the orbit?

A. $R^3 \propto T^2$

B. $\dfrac{1}{R^3} \propto T^2$

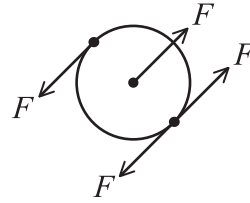C. $R^2 \propto T^3$

D. $\dfrac{1}{R^2} \propto T^3$

15. A metal disc is acted upon by a number of forces. The forces are all in the plane of the disc and the weight of the disc is negligible.

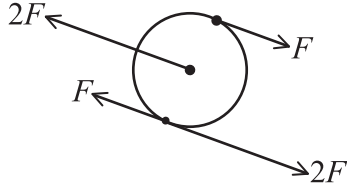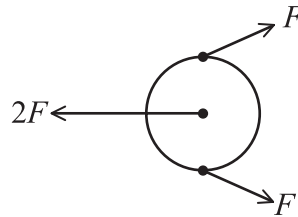In which of the following situations is the disc in equilibrium?

A.
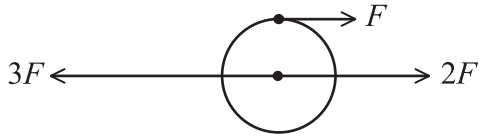
B.

C.

D.

16. A temperature scale is to be constructed using the property X of a substance.

Which of the following must be a characteristic of the property X?

A.   The value of the property must be zero at zero kelvin.

B.   The property must increase with increase of temperature.

C.   The property must have a different value at each temperature to be measured.

D.   The value of the property must vary linearly with kelvin temperature.

17. As part of an experiment to determine the latent heat of vaporisation of water, a student boils some water in a beaker using an electric heater as shown below.
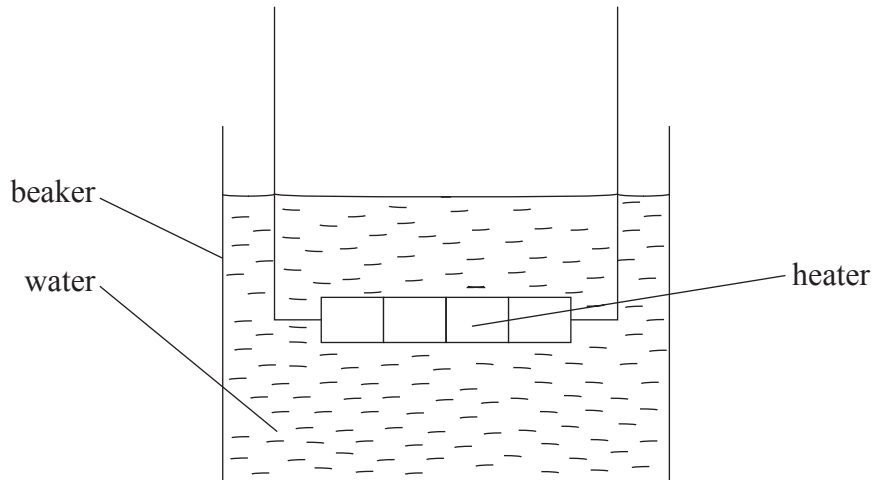
The student notes two sources of error.

Error 1: thermal energy is lost from the sides of the beaker
Error 2: as the water is boiling, water splashes out of the beaker

Which of the following gives the correct effect of these two errors on the calculated value for the specific latent heat?

	Error 1	Error 2
A.	Increase	Decrease
B.	Increase	No change
C.	Decrease	Increase
D.	Decrease	No change

18. Which of the following is **not** an assumption on which the kinetic model of an ideal gas is based?

A. All molecules behave as if they are perfectly elastic spheres.

B. The mean-square speed of the molecules is proportional to the kelvin temperature.

C. Unless in contact, the forces between molecules are negligible.

D. The molecules are in continuous random motion.

19. Which of the following is the internal energy of a system?

    A.   The total thermal energy gained by the system during melting and boiling.

    B.   The sum of the potential and the kinetic energies of the particles of the system.

    C.   The total external work done on the system during melting and boiling.

    D.   The change in the potential energy of the system that occurs during melting and boiling.

20. The graph below shows the variation with volume V of the pressure p of a gas during one cycle of an engine.
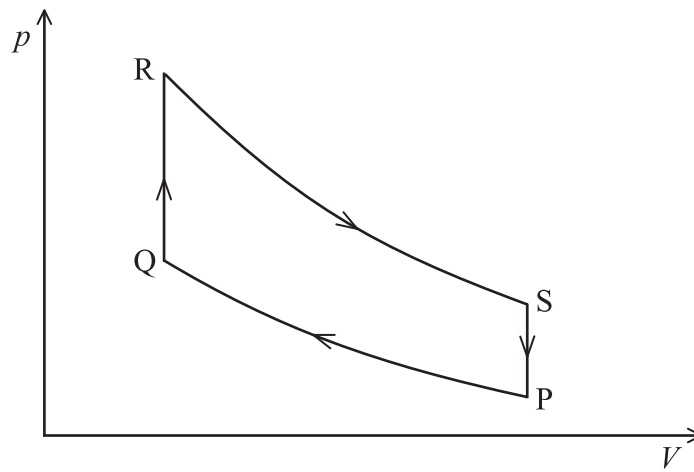
During which operations, PQ, QR, RS and SP does the gas do external work?

    A.   PQ only

    B.   RS only

    C.   QR and RS only

    D.   PQ and RS only

21. A Carnot engine takes in thermal energy at kelvin temperature H and rejects some of this energy at kelvin temperature L. Which of the following expressions gives the efficiency of the engine?

A. $\dfrac{L}{H}$

B. $\dfrac{H}{L} - 1$

C. $\dfrac{H}{L} + 1$

D. $1 - \dfrac{L}{H}$

22. Which of the following diagrams best illustrates the diffraction of waves by an obstacle?

A.

B.

C.

D.
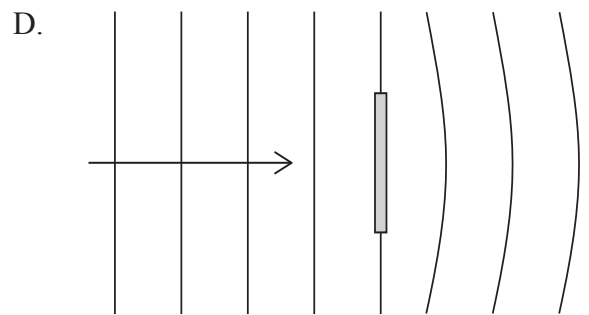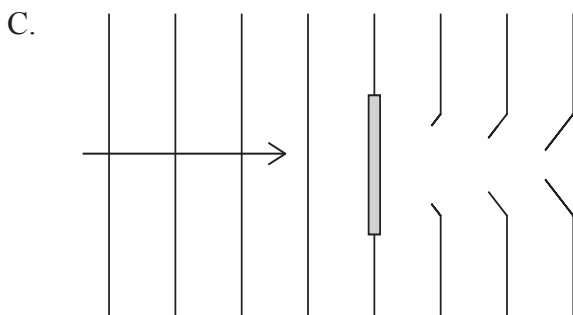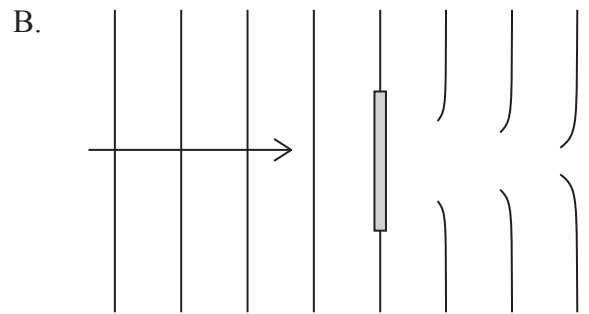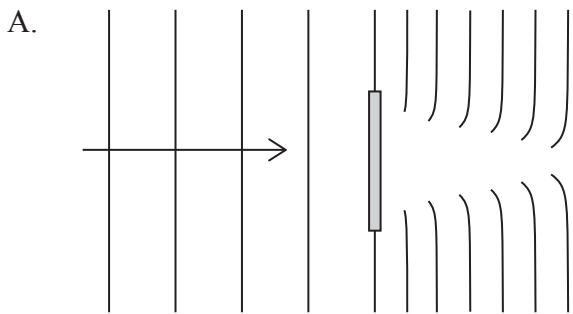
23. A loudspeaker emits sound of frequency f. The sound waves are reflected from a wall. The arrangement is shown below.
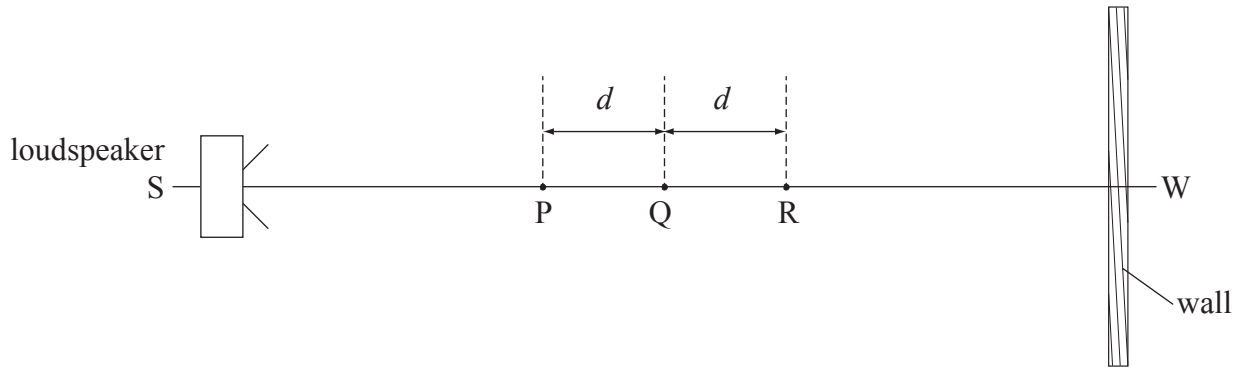
When a microphone is moved along the line SW, minimum loudness of sound is detected at points P, Q and R. There are no other minima between these points. The separation of the minima is d.

The speed of the sound wave is

A. $\frac{1}{2}fd$.

B. $\frac{f}{d}$.

C. fd.

D. $2fd$.

24. A source S produces sound waves of frequency f and is moving along a straight line as shown below.
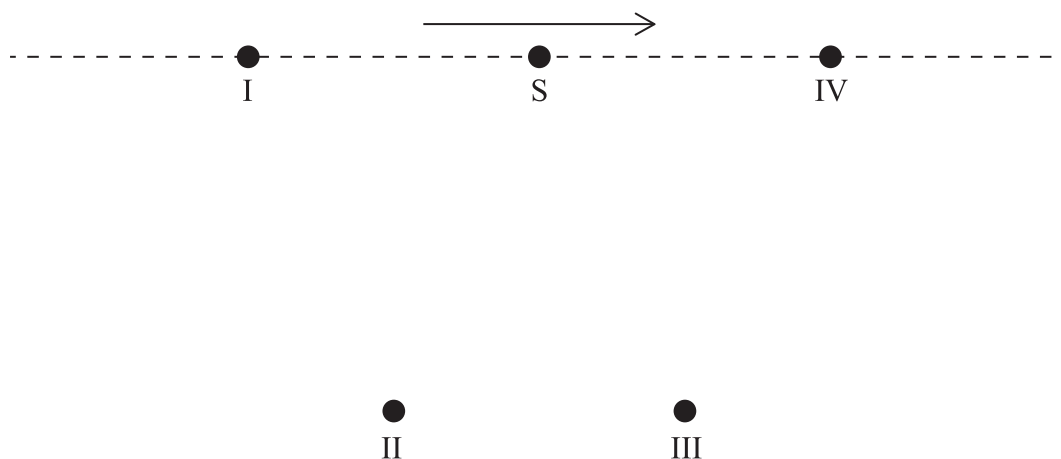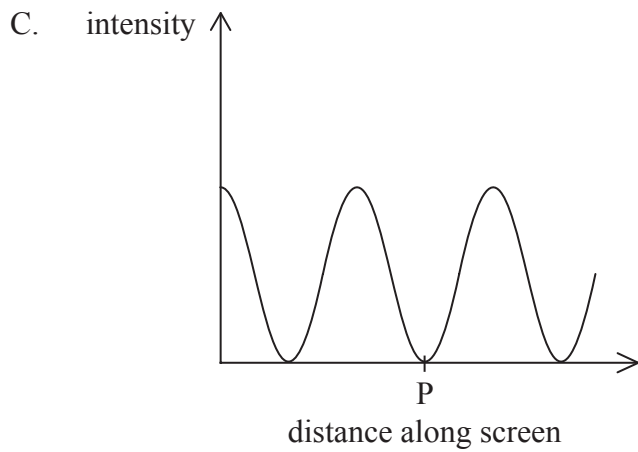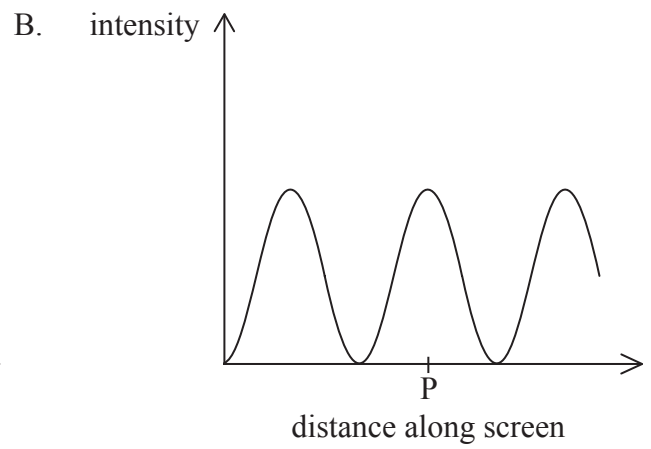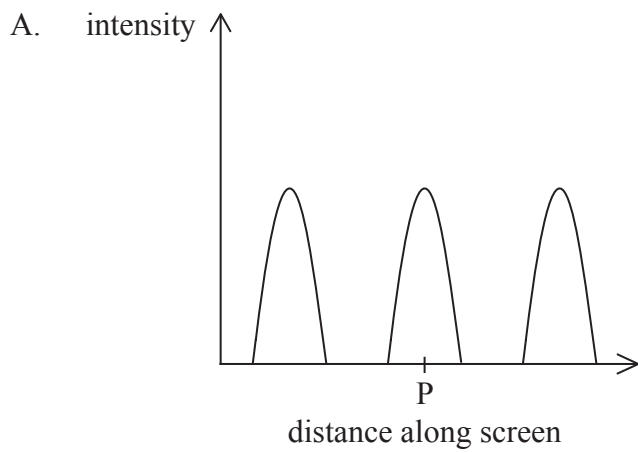

Which observer I, II, III or IV could hear a sound of frequency f when the source is in the position shown?

A. I

B. II

C. III

D. IV

25. In order that the interference between the waves emitted by two light sources can be observed, it is essential that the sources must emit waves that

A. have the same amplitude.

B. are in phase.

C. have the same colour.
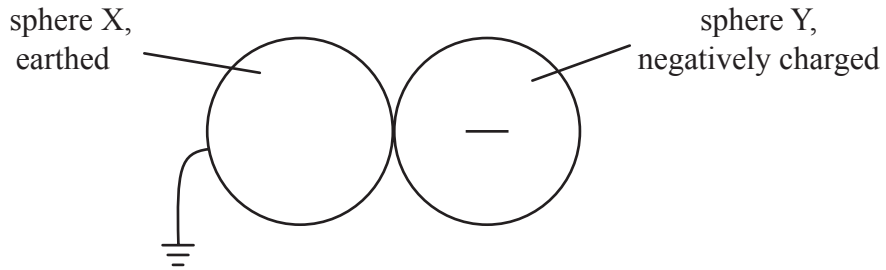
D. have a constant phase difference between them.

26. The interference of light waves is observed using a double-slit arrangement as shown below.

monochromatic
light source *

P

screen

not to scale
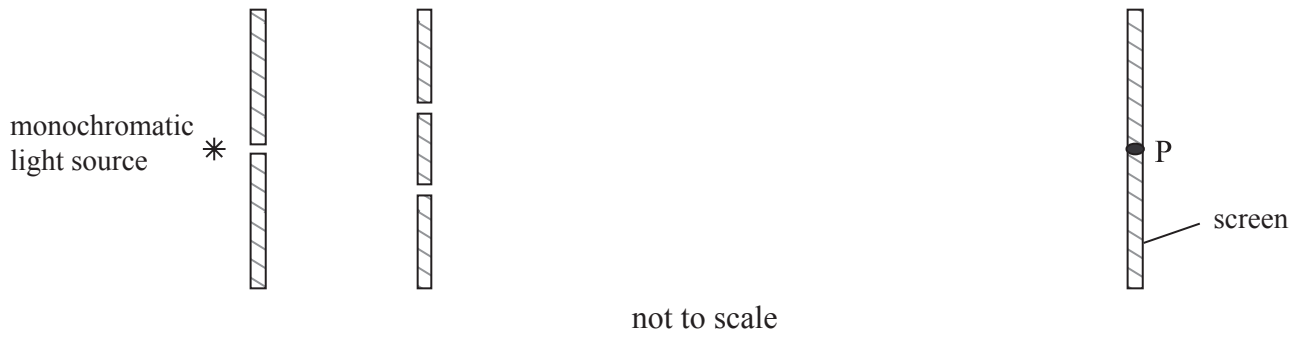
Which of the following best shows the intensity distribution of light near point P on the screen?

A.   intensity

P
distance along screen

B.   intensity

P
distance along screen

C.   intensity

P
distance along screen

D.   intensity

P
distance along screen

Turn over
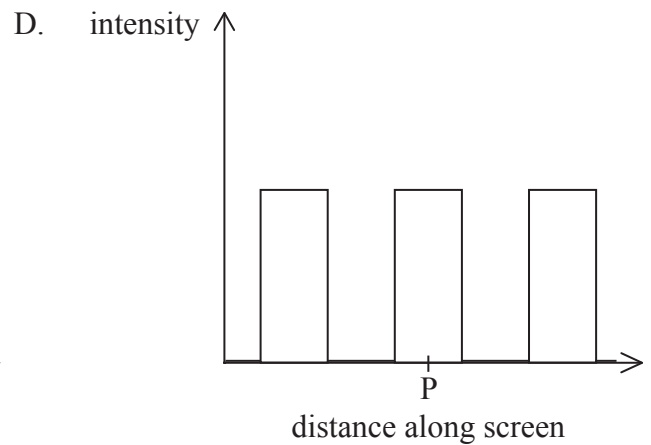
27. Two isolated spheres X and Y of unknown materials are touching one another as shown below.

sphere X, earthed

sphere Y, negatively charged

Sphere Y is negatively charged and sphere X is earthed. The earth connection is removed from sphere X and then the spheres are separated as shown below.


sphere X, positively charged

sphere Y, negatively charged
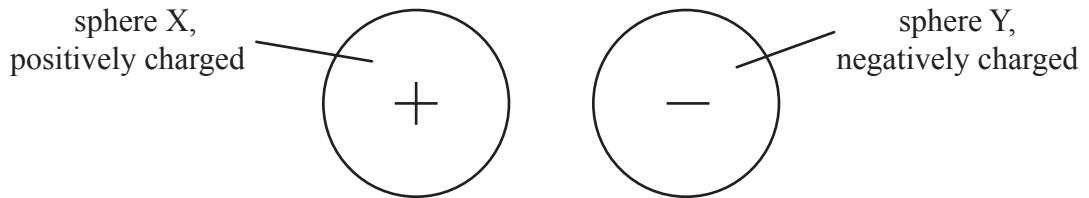
Sphere X is found to be positively charged and sphere Y remains negatively charged.

Which of the following describes the nature of the materials from which the spheres are made?

	Sphere X	**Sphere Y**
A.	Insulator	Insulator
B.	Insulator	Conductor
C.	Conductor	Insulator
D.	Conductor	Conductor

28. The diagram below shows two parallel conducting plates that are oppositely charged.
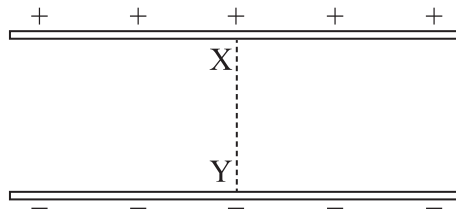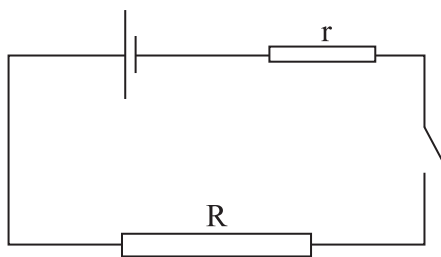

The line XY is perpendicular to the plates.

Which of the following diagrams shows the variation along the line XY of the magnitude E of the electric field strength between the plates?

A.

B.

C.

D.

Turn over
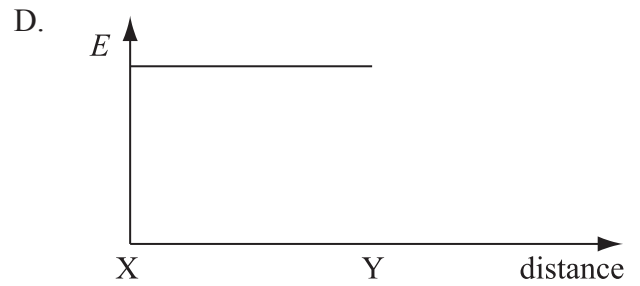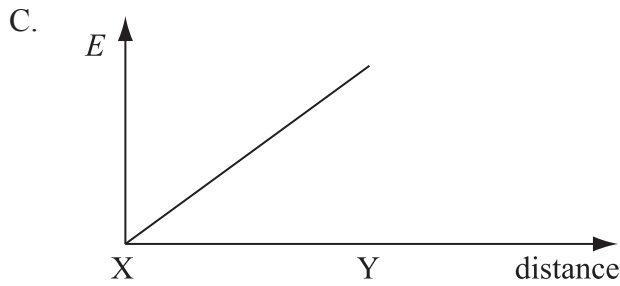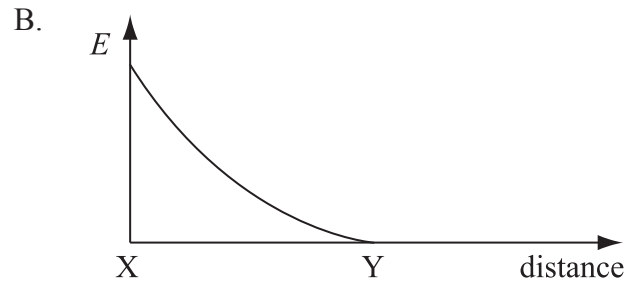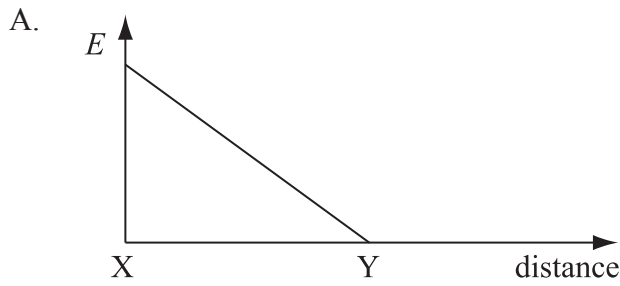
29. The current in the circuit shown below is constant when the switch is closed.


The energy transfer in the internal resistance r of the battery is 15 J when a charge of 40 C passes through it. For the same amount of charge, 45 J of energy is transferred in the resistor R.
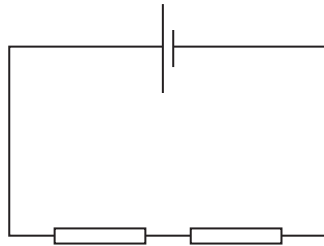
Which of the following gives the e.m.f. of the battery?

A. $\dfrac{15}{40}$ V

B. $\dfrac{30}{40}$ V

C. $\dfrac{45}{40}$ V
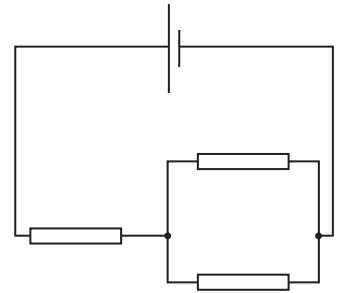
D. $\dfrac{60}{40}$ V

30. In the circuits below, the cells each have the same e.m.f. and zero internal resistance. All the resistors have the same resistance.
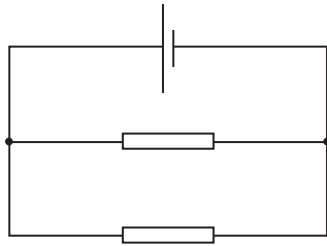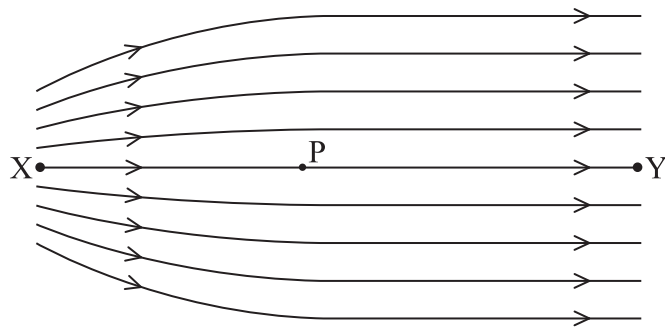

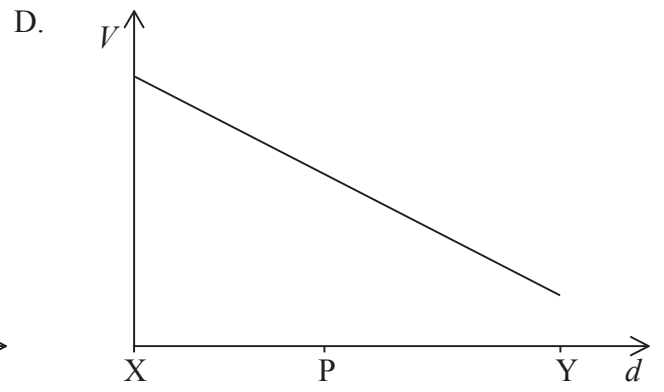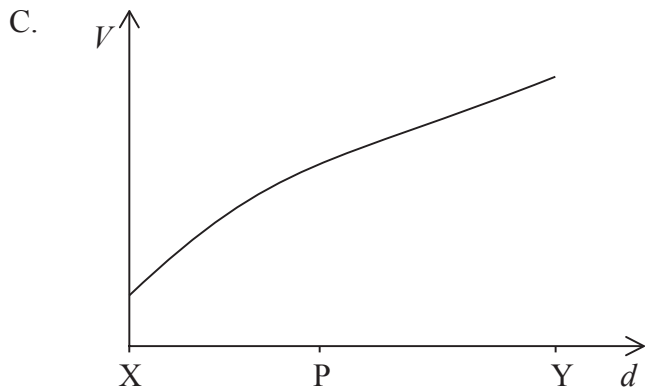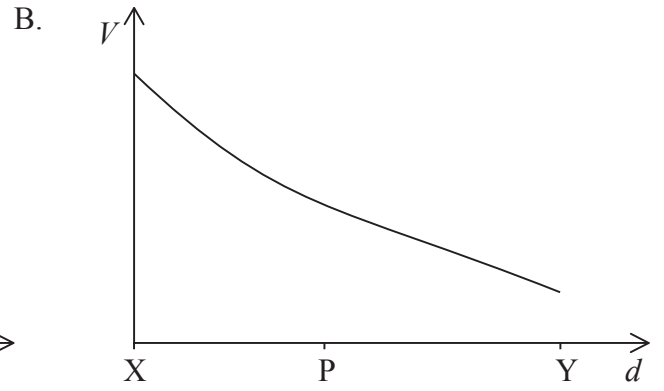Circuit X   Circuit Y   Circuit Z
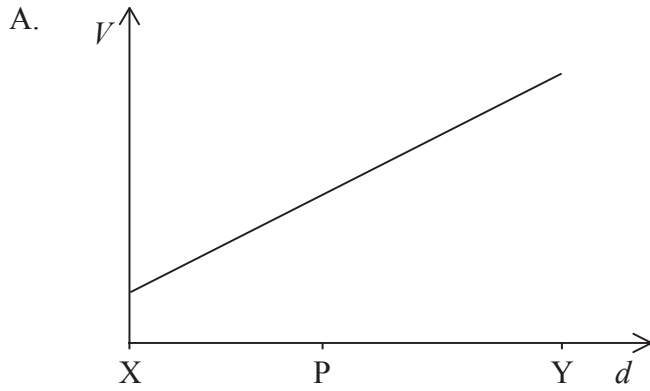
Which of the following gives the current through the cells in order of **increasing** magnitude?

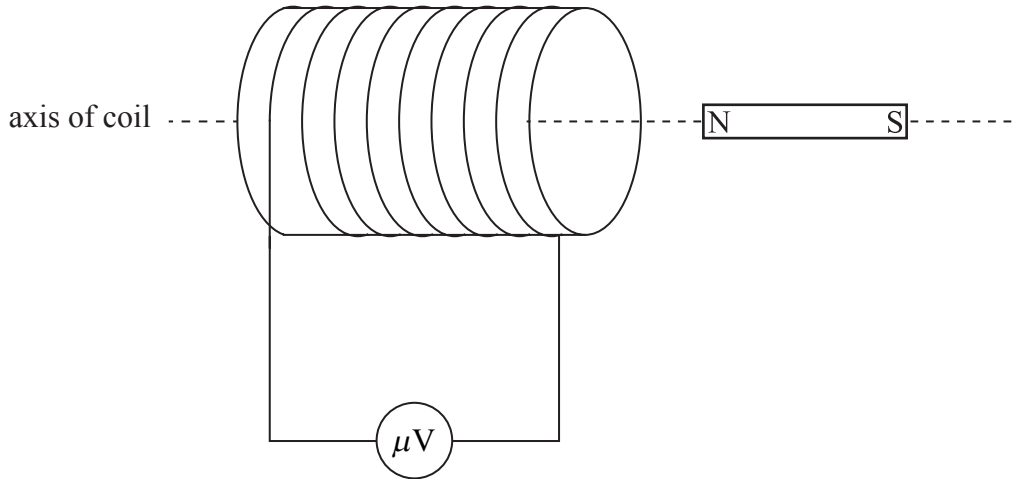|	Lowest current	→	Highest current
A.	X	Y	Z
B.	Z	X	Y
C.	Y	Z	X
D.	Y	X	Z

31. The diagram below shows electric field lines in a region of space.

Which of the following diagrams best shows the variation with distance d of the potential V along the line XY?

A.

B.

C.

D.

32. The north pole of a permanent bar magnet is pushed along the axis of a coil as shown below.


The pointer of the sensitive voltmeter connected to the coil moves to the right and gives a maximum reading of 8 units. The experiment is repeated but on this occasion, the south pole of the magnet enters the coil at twice the previous speed.

Which of the following gives the maximum deflection of the pointer of the voltmeter?

A.   8 units to the right

B.   8 units to the left

C.   16 units to the right

D.   16 units to the left

33. The diagram below shows an ideal transformer.

input

output

primary coil
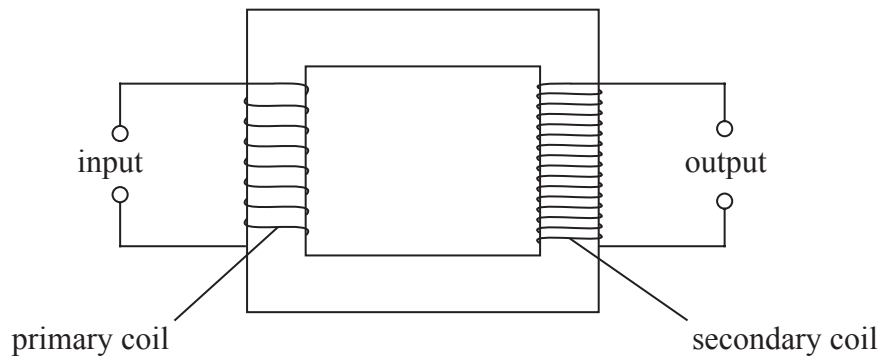
secondary coil

The transformer has n turns on the primary coil and $2n$ turns on the secondary coil. The waveform produced on the screen of a cathode-ray oscilloscope (c.r.o.), when the c.r.o. is connected to the primary coil, is shown below.
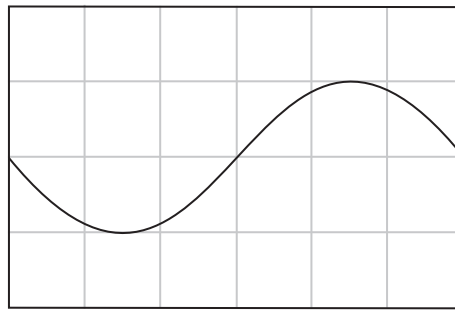
Which of the following diagrams shows the waveform displayed on the c.r.o. when it is connected to the secondary coil? The settings of the c.r.o. remain unchanged.

A.

B.

C.

D.
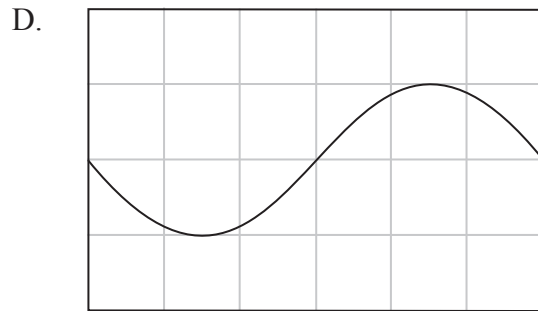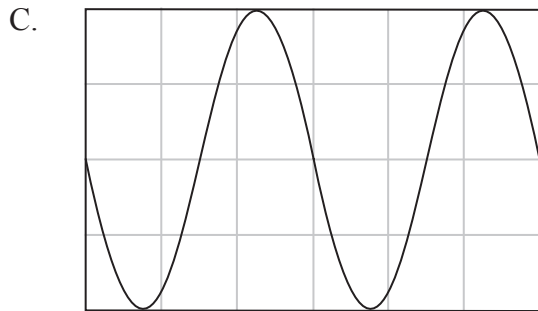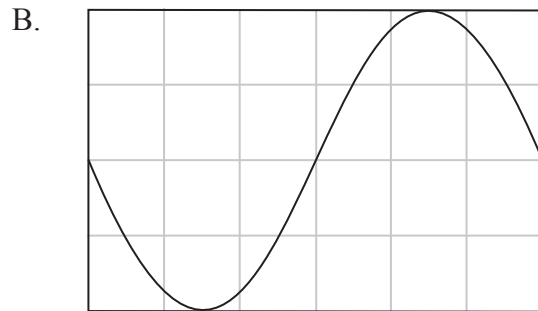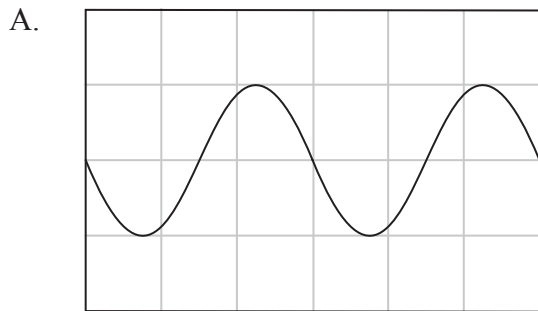
34. In an α-particle scattering experiment (Geiger-Marsden experiment), the number n of particles incident per unit time on a detector was determined for different angles of deflection θ.
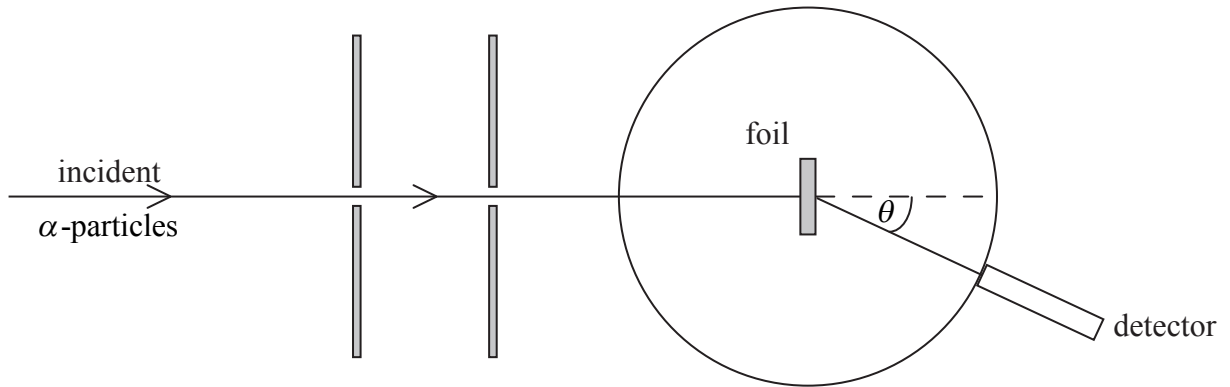
Which of the following graphs best shows the variation with θ of n?

A.

B.

C.

D.
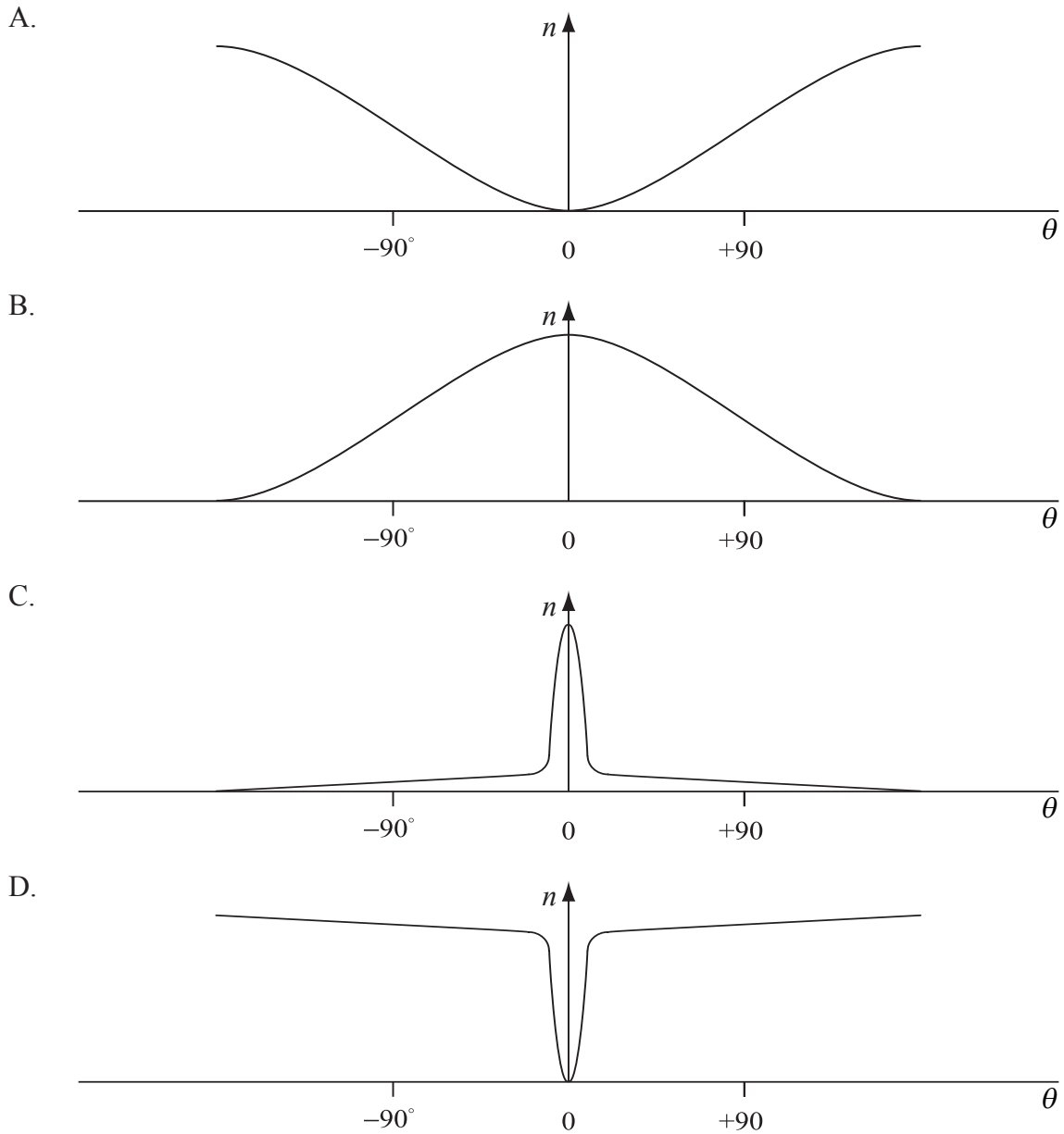
35. When a high-energy α-particle collides with an aluminium-27 $\left({}^{27}_{13}\text{Al}\right)$ nucleus, a nucleus of phosphorus may be produced.

Which of the following equations correctly shows this transmutation?

A. ${}^{27}_{13}\text{Al} + {}^{4}_{2}\text{He} \rightarrow {}^{30}_{15}\text{P} + {}^{1}_{0}\text{n}$

B. ${}^{27}_{13}\text{Al} + {}^{4}_{2}\text{He} \rightarrow {}^{30}_{15}\text{P} + {}^{1}_{0}\text{p}$
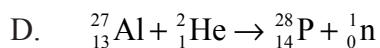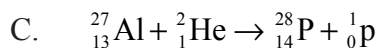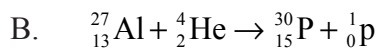
C. ${}^{27}_{13}\text{Al} + {}^{2}_{1}\text{He} \rightarrow {}^{28}_{14}\text{P} + {}^{1}_{0}\text{p}$

D. ${}^{27}_{13}\text{Al} + {}^{2}_{1}\text{He} \rightarrow {}^{28}_{14}\text{P} + {}^{1}_{0}\text{n}$
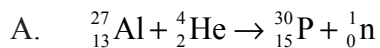
36. The photoelectric effect involves the emission of electrons from

A.   the surface of a metal when the metal is heated.

B.   the surface of a metal when it is illuminated with electromagnetic radiation.

C.   an atom of a material when the material is negatively charged.

D.   an atom of a material when the material is heated.

37. An α-particle having a de Broglie wavelength λ_i collides with a stationary carbon nucleus. The α-particle moves off in a different direction as shown below.

initial direction of α-particle, de Broglie wavelength λ_i

final direction of α-particle, de Broglie wavelength λ_f

final direction of carbon nucleus, de Broglie wavelength λ_c
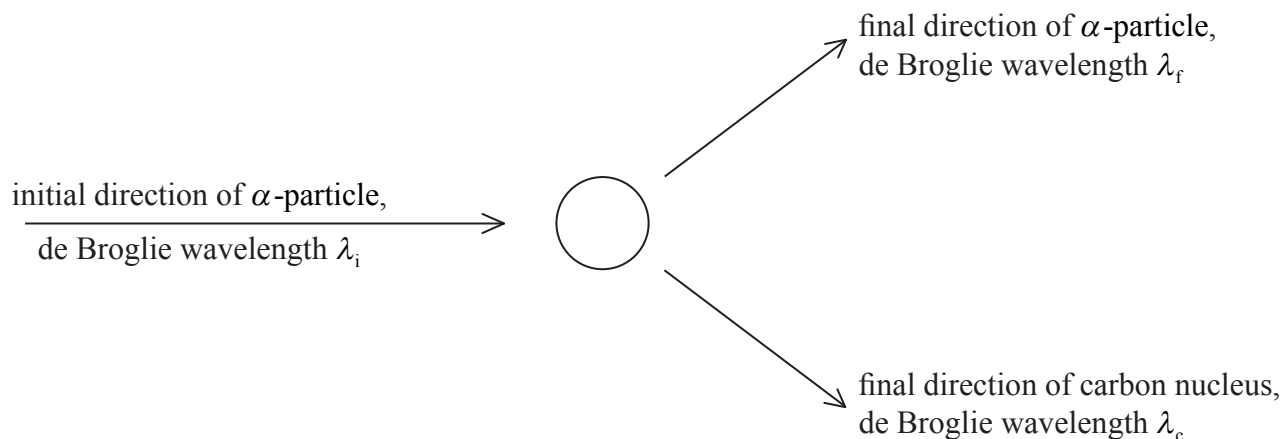
After the collision, the de Broglie wavelengths of the α-particle and the carbon nucleus are λ_f and λ_c respectively.

Which of the following is a true statement related to the de Broglie wavelengths?

A. $\lambda_i < \lambda_f$

B. $\lambda_i > \lambda_f$

C. $\lambda_f = \lambda_c$

D. $\lambda_i = \lambda_c$

38. The diagram below shows four electron energy levels E_3, E_2, E_1 and E_0 in an atom of a gas.

$$\text{——————— } E_3$$

$$\text{——————— } E_2$$

$$\text{——————— } E_1$$

increasing energy

$$\text{——————— } E_0$$
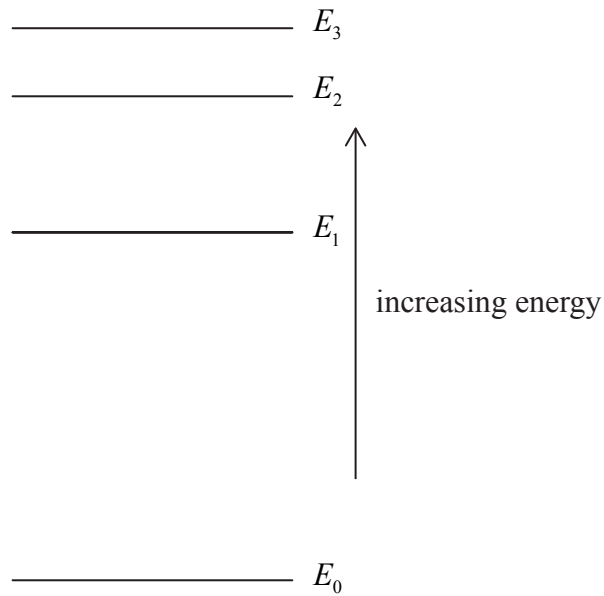
Which of the following gives the number of lines in the spectrum of the gas that are associated with these energy levels?

A.   3

B.   4

C.   5

D.   6

39. The diagram below shows the variation with wavelength of the intensity of the X-ray radiation produced when electrons are incident on a metal target.
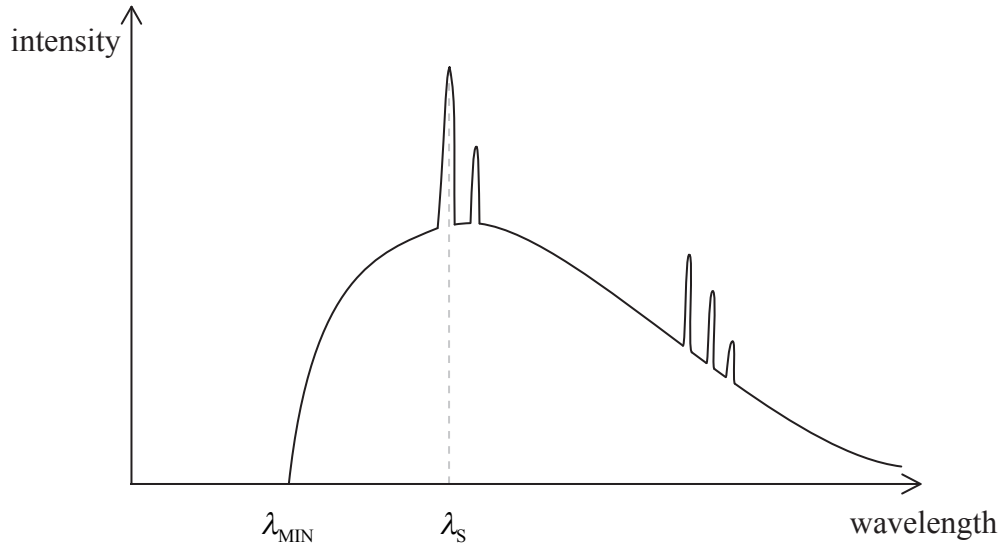
The minimum wavelength of the X-rays and the wavelength of one of the spectral lines are λ_{MIN} and λ_S respectively.

Which of the following correctly describes the change, if any, in λ_{MIN} and λ_S when the energy of the incident electrons is **increased**.

	λ_{MIN}	λ_S
A.	No change	Smaller
B.	Smaller	No change
C.	Smaller	Larger
D.	Larger	No change

40. To which of the following classes of particles does a meson belong?

A. Exchange bosons

B. Hadrons

C. Leptons

D. Quarks