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

PHYSICS
HIGHER LEVEL
PAPER 1

Monday 19 May 2003 (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. Natalie measures the mass and speed of a glider. The percentage uncertainty in her measurement of the mass is 3 % and in the measurement of the speed is 10 %. Her calculated value of the kinetic energy of the glider will have an uncertainty of

   A.   30 %.

   B.   23 %.

   C.   13 %.

   D.   10 %.

2. The graph shows the variation with time t of the velocity v of an object.
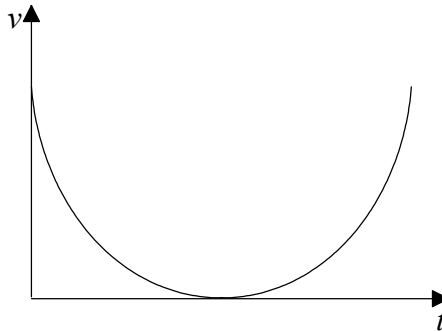
Which **one** of the following graphs best represents the variation with time t of the acceleration a of the object?
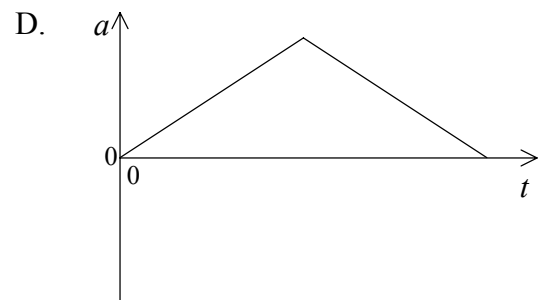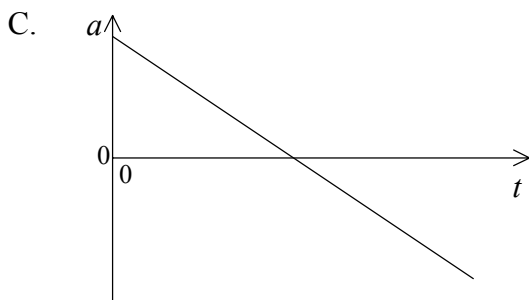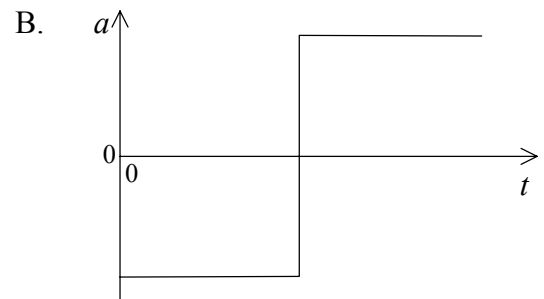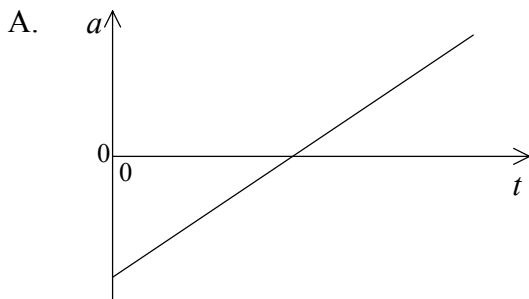
3. A rocket is fired vertically. At its highest point, it explodes. Which **one** of the following describes what happens to its total momentum and total kinetic energy as a result of the explosion?

|	Total momentum	Total kinetic energy
A.	unchanged	increased
B.	unchanged	unchanged
C.	increased	increased
D.	increased	unchanged

4. Which **one** of the following units is a unit of energy?

A. eV

B. $W\,s^{-1}$

C. $W\,m^{-1}$

D. $N\,m\,s^{-1}$

5. Two satellites of equal mass, S_1 and S_2, orbit the Earth. S_1 is orbiting at a distance r from the Earth's centre at speed v. S_2 orbits at a distance $2r$ from the Earth's centre at speed $\dfrac{v}{\sqrt{2}}$. The ratio of the centripetal force on S_1 to the centripetal force on S_2 is

A. $\dfrac{1}{8}$.

B. $\dfrac{1}{4}$.

C. 4.

D. 8.

Turn over

**6.**   A block is at rest on a rough plane inclined at an angle θ relatively to the horizontal.
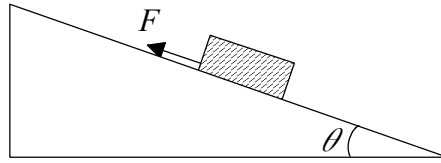

The angle θ is slowly reduced. Which **one** of the following correctly describes the changes, if any, in the frictional force F and the coefficient of static friction between the block and the plane?

|	**Frictional force F**	**Coefficient of static friction**
A.	decreases	increases
B.	decreases	constant
C.	increases	increases
D.	increases	constant

7.   A powered spaceship is moving directly away from a planet as shown below.
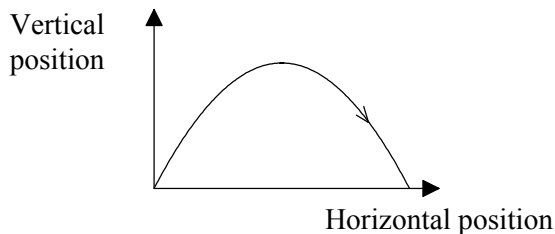

At point P the motors of the spaceship are switched off but the spaceship remains under the influence of the planet. Which **one** of the following graphs best represents the variation with time t of the **velocity** v of the spaceship after it passes point P?
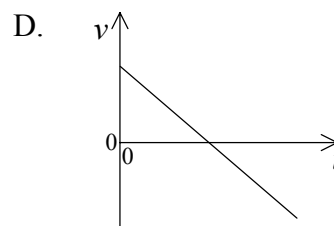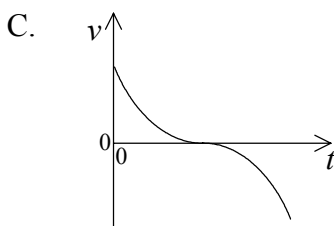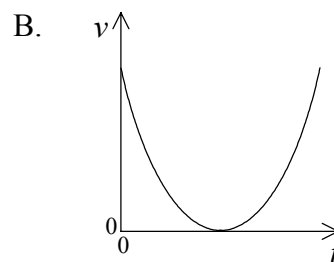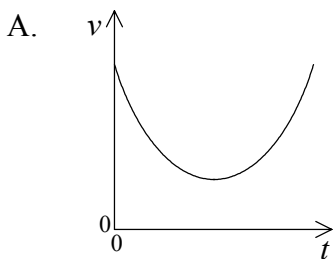
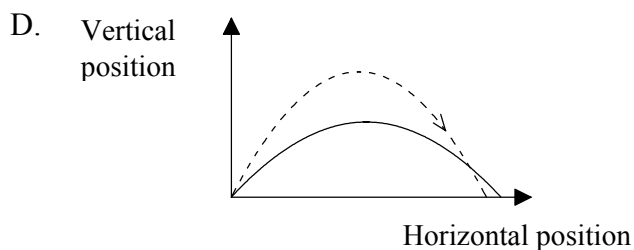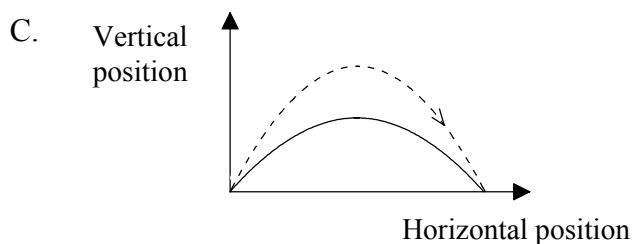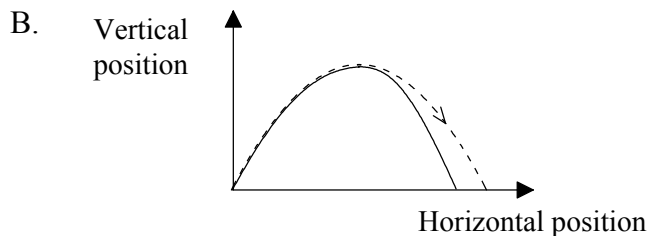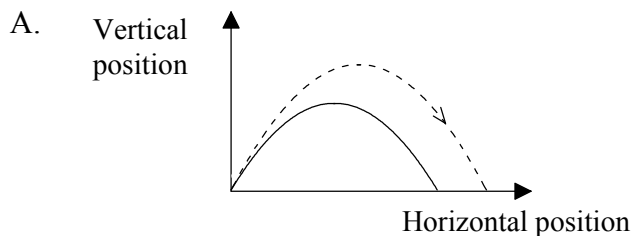**8.** Which **one** of the following graphs best represents the variation of the kinetic energy, KE, and of the gravitational potential energy, GPE, of an orbiting satellite with its distance r from the centre of the Earth?

A.   Energy

KE

0

GPE

r

B.   Energy

KE

0

GPE

r

C.   Energy

KE

0

GPE

r

D.   Energy

GPE

0

KE

r
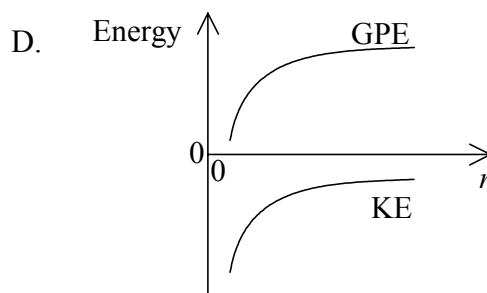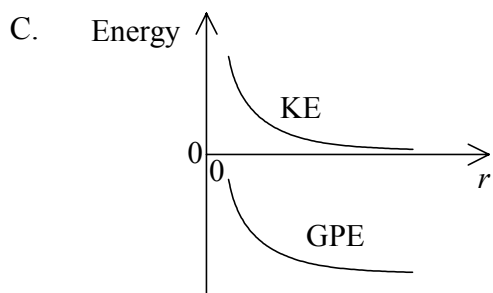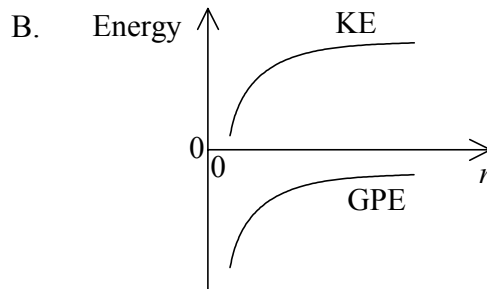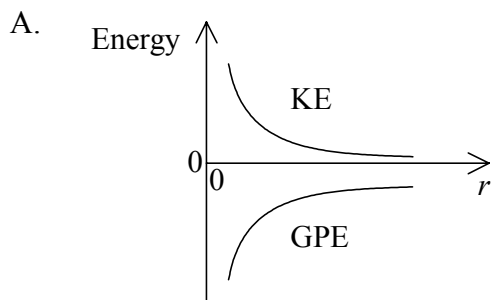
9. The diagram below shows the path of a projectile in the absence of air resistance.

Vertical position

Horizontal position

Which **one** of the following diagrams best represents the path of the projectile under the same initial conditions when the air resistance is taken into account? *(The path in absence of air resistance is shown for comparison as a dotted line.)*

A.   Vertical position

Horizontal position

B.   Vertical position

Horizontal position

C.   Vertical position

Horizontal position

D.   Vertical position

Horizontal position

10.   A sailing boat is moving with constant velocity *v* to the right parallel to the dock.
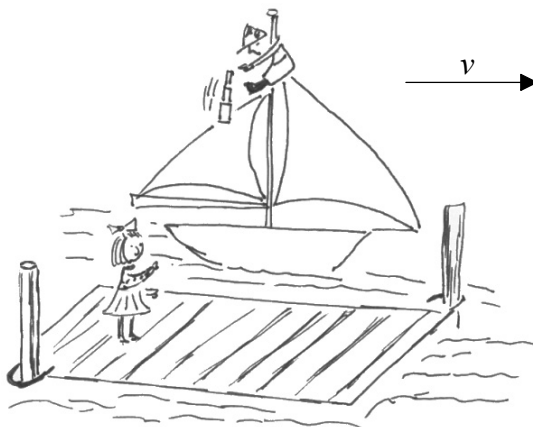
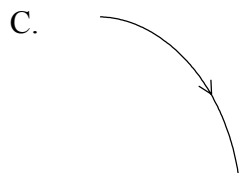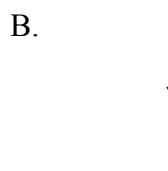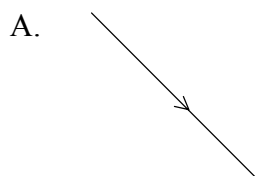Sailor Hulot, up on the mast, drops his telescope at the moment he is opposite Lucie who is standing on the dock. Which **one** of the following best shows the path of the falling telescope as seen by Lucie?

A.

B.

C.

D.
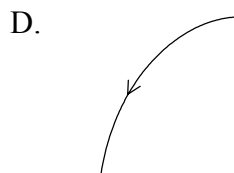
11.   The specific latent heat of vaporization of a substance is the quantity of energy required to

A.   raise the temperature of a unit mass of a substance by one degree centigrade.

B.   convert a unit mass of liquid to vapour at constant temperature and pressure.

C.   convert a unit mass of solid to vapour at constant temperature and pressure.

D.   convert a unit mass of liquid to vapour at a temperature of $100\,°C$ and a pressure of one atmosphere.

12. When a gas in a cylinder is compressed at constant temperature by a piston, the pressure of the gas increases. Consider the following three statements.
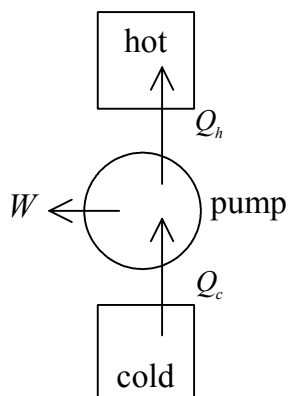
      I.   The rate at which the molecules collide with the piston increases.

      II.   The average speed of the molecules increases.

      III.   The molecules collide with each other more often.

Which statement(s) correctly explain the increase in pressure?
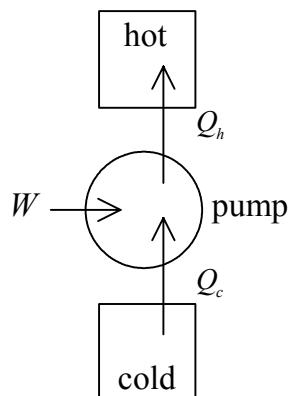
A.   I only

B.   II only

C.   I and II only

D.   I and III only

13. When a gas in a thermally insulated cylinder is suddenly compressed, the change of state is

A.   adiabatic.

B.   isothermal.

C.   isobaric.

D.   isochoric.

14. Which **one** of the following diagrams correctly represents the directions of the energy transfers that take place in a heat pump?
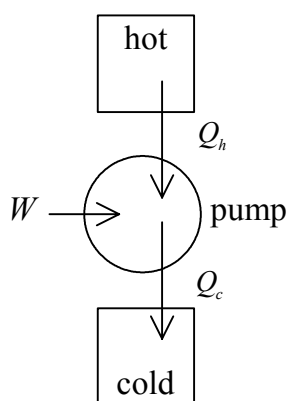
A.

```
        hot
         ↑
          Q_h
  W ←─○  pump
         ↑
          Q_c
        cold
```

B.

```
        hot
         ↑
          Q_h
  W →○  pump
         ↑
          Q_c
        cold
```

C.

```
        hot
         ↓
          Q_h
  W →○  pump
         ↓
          Q_c
        cold
```

D.

```
        hot
         ↓
          Q_h
  W ←○  pump
         ↓
          Q_c
        cold
```
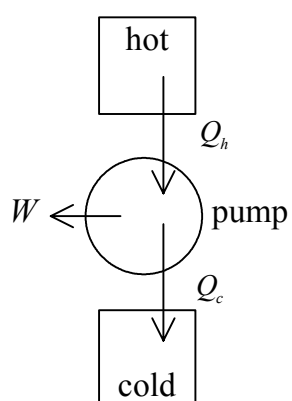
15. The graph below shows the variation with volume of the pressure of a system.

Pressure / 10^5 Pa

Volume / m^3
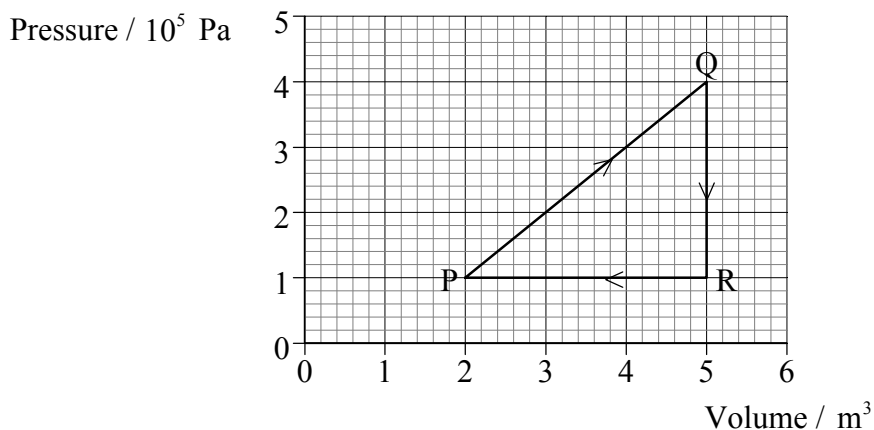
The work done in compressing the gas from R to P is

A. 5.0×10^5 J.

B. 4.5×10^5 J.

C. 3.0×10^5 J.

D.   0.

16. Water waves at the surface of a pond pass a floating log of length L. The log is at rest relative to the bank. The diagram shows wave crests at one instant.

The number of crests passing the log per unit time is N. The speed of the water waves relative to the log at rest is

A. $\dfrac{L}{7}(N-1)$.

B. $\dfrac{L}{6}(N-1)$.

C. $\dfrac{L}{7}(N)$.

D. $\dfrac{L}{6}(N)$.

17. Two identical triangular pulses of amplitude X travel toward each other along a string. At the instant shown on the diagram, point M is midway between the two pulses.
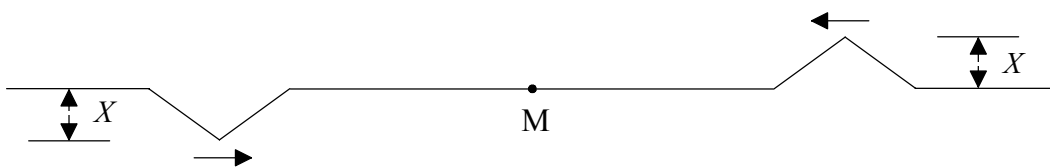

The amplitude of the disturbance in the string as the pulses move through M is

A. $2X$.

B. X.

C. $\dfrac{X}{2}$.

D.   0.

18. The following are phenomena associated with waves.

   I.   Reflection

   II.   Refraction

   III   Diffraction

Which of these phenomena can be understood by applying Huygens' principle?

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

19. A person is walking along one side of a building and a car is driving along another side of the building.
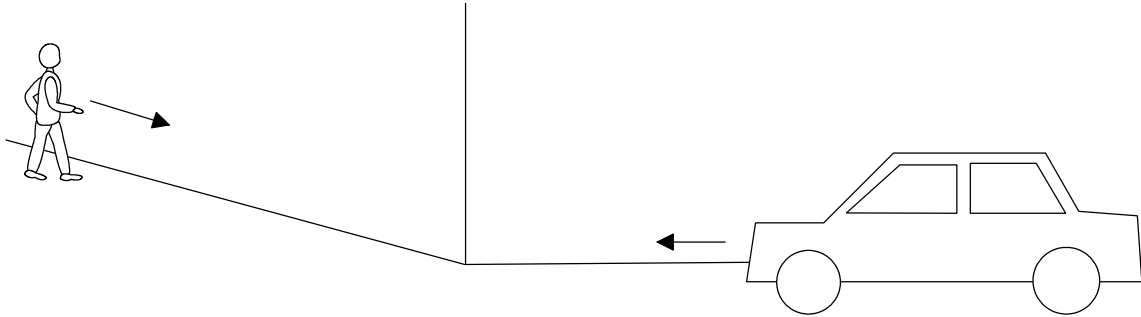
The person can hear the car approach but cannot see it. This is explained by the fact that sound waves

A.   travel more slowly than light waves.

B.   are diffracted more at the corner of the building than light waves.

C.   are refracted more at the corner of the building than light waves.

D.   are longitudinal waves.

20. A sound emitting source moves along a straight line with speed v relative to an observer at rest.
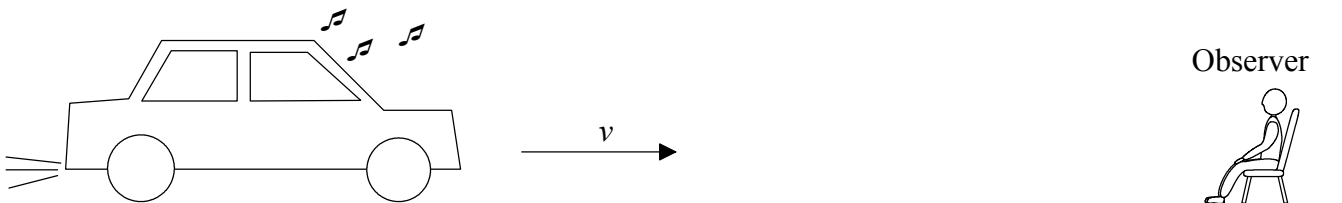

The speed of sound relative to the medium is c. The observer measures the speed of sound emitted by the source as

A. c.

B. $c + v$.

C. $c - v$.

D. $v - c$.

21. The production of beats can be explained by the superposition of waves with slightly different

  A.   amplitudes.

  B.   directions.

  C.   frequencies.

  D.   speeds.

22. The diagram below shows ocean waves incident on a stone barrier protecting boats anchored behind it.
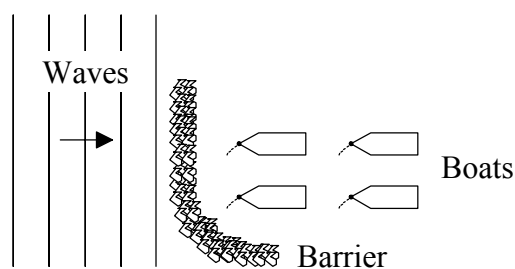
The boats could still be at risk of damage by waves mainly as a result of

  A.   refraction.

  B.   standing waves.

  C.   diffraction.

  D.   reflection.

23. In a Young's double slit interference experiment, which **one** of the following changes will increase the fringe separation?

  A.   Decreasing the wavelength

  B.   Increasing the wavelength

  C.   Increasing the slit separation

  D.   Decreasing the distance between the slit and the screen

24. A positively charged sphere falls vertically in a vacuum between two long parallel plates carrying opposite charges. Which **one** of the following diagrams best shows the path followed by the sphere?
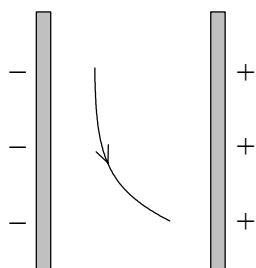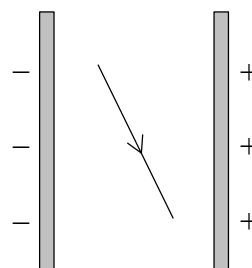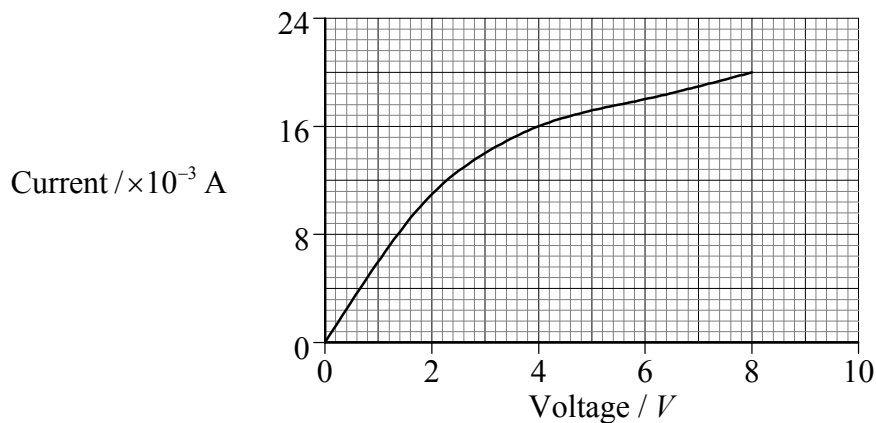
A.
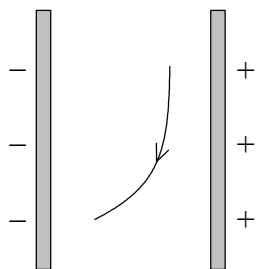
B.
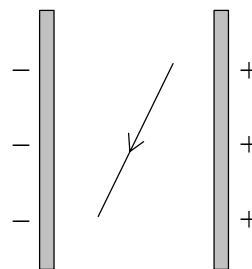
C.

D.

25. The graph shows the current/voltage characteristics of a filament lamp.

Current / ×10^{-3} A

Voltage / V

The resistance of the filament at 4.0 V is

A.   250 Ω.

B.   4 000 Ω.

C.   8 000 Ω.

D.   64 000 Ω.

Turn over

26. An electric motor is used to raise a weight of 2.0 N. When connected to a 4.0 V supply, the current in the motor is 1.5 A. Assuming no energy losses, the best estimate for the maximum steady speed at which the weight can be raised is

    A. $0.3\,\text{ms}^{-1}$.

    B. $3.0\,\text{ms}^{-1}$.

   C. $9.0\,\text{ms}^{-1}$.

    D. $12.0\,\text{ms}^{-1}$.

27. The diagram shows the electric field lines produced by an electrostatic focussing device.
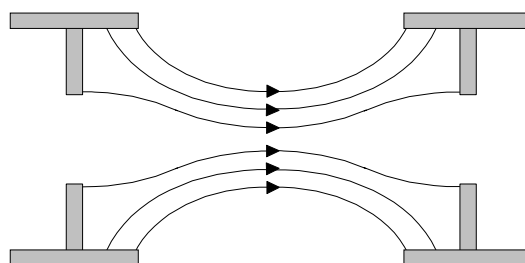
Which **one** of the following diagrams best shows the corresponding equipotential lines? The electric field lines are shown as broken lines on each of the diagrams.

A.

B.

C.

D.
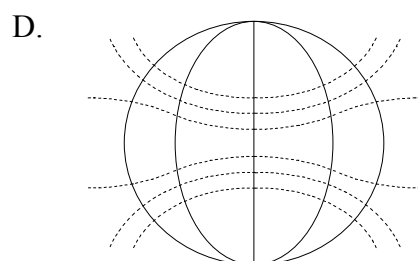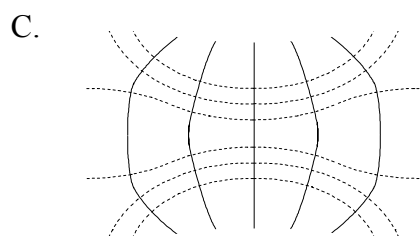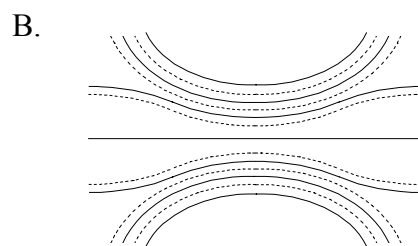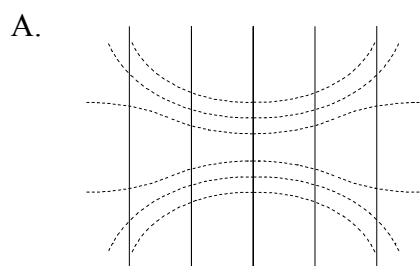
28. The diagram below shows the path XY of an electron that passes through a thin foil placed in a vacuum.
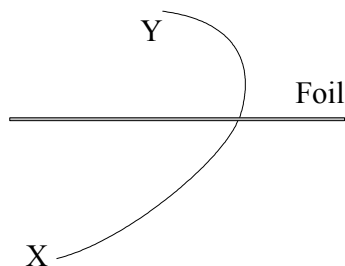
There is a uniform magnetic field acting perpendicularly to the plane of the page. Which **one** of the following statements best explains the path followed by the electron?

|	**Direction of motion of the electron**	**Direction of the magnetic field**
A.	Y to X	into the plane of the page
B.	Y to X	out of the plane of the page
C.	X to Y	into the plane of the page
D.	X to Y	out of the plane of the page

29. A circular coil of wire of radius r is placed in a uniform magnetic field of flux density B. The angle between the plane of the coil and the magnetic field is θ.
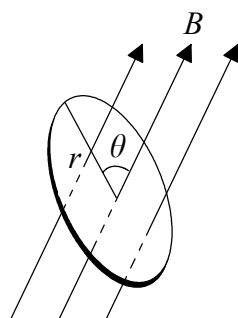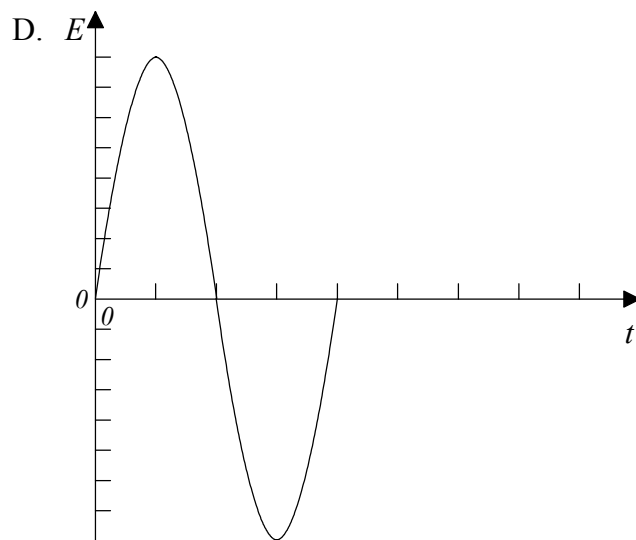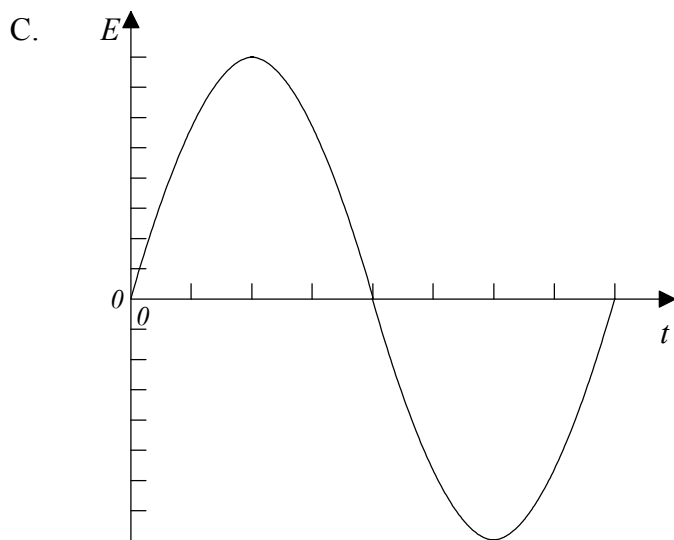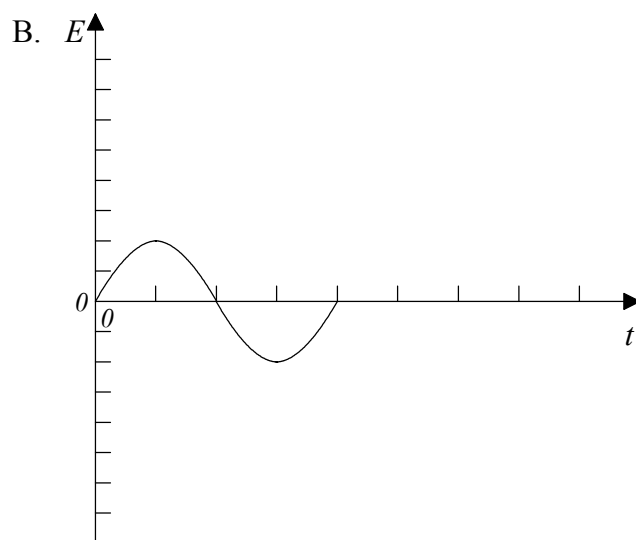

The magnetic flux linking the coil is

A. $\pi r^2 B$.

B. $\pi r^2 B \sin\theta$.

C. $\pi r^2 B \cos\theta$.

D. $2\pi r B$.

Turn over

30. When a coil is rotated in a uniform magnetic field at a certain frequency, the variation with time t of the induced e.m.f. E is as shown below.
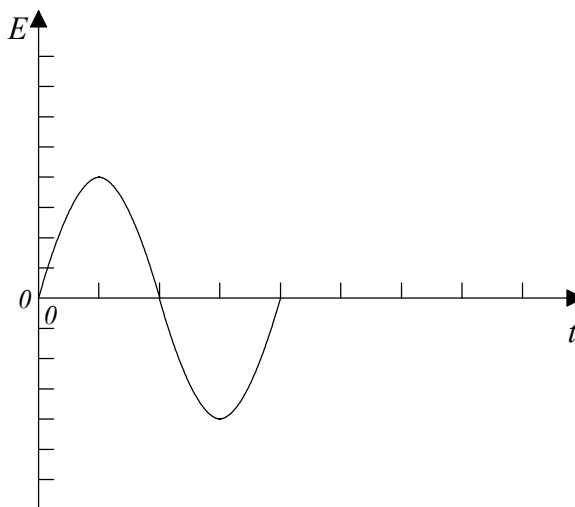
The frequency of rotation of the coil is reduced to **one half** of its initial value. Which **one** of the following graphs correctly shows the new variation with time t of the induced e.m.f. E?

A.

B.

C.

D.
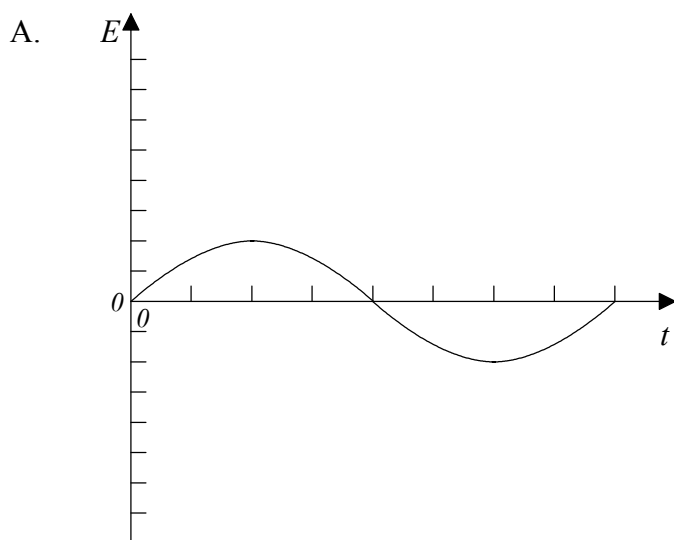
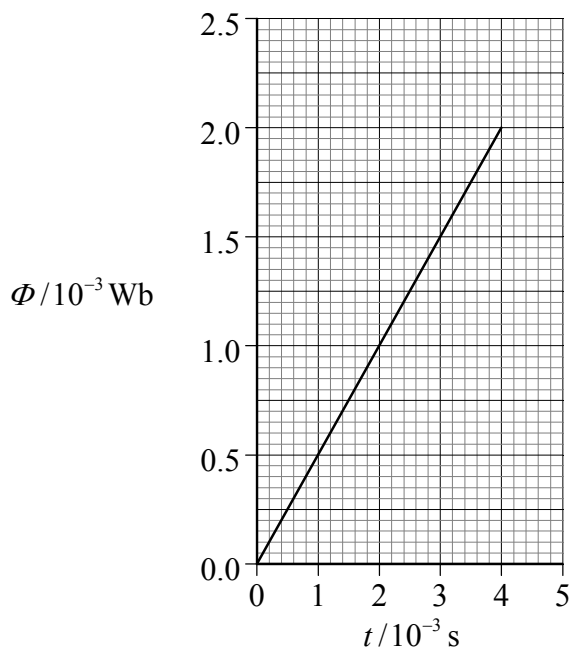**31.** The magnetic flux Φ through a coil having 500 turns varies with time t as shown below.


The magnitude of the e.m.f. induced in the coil is

A.   0.25 V.

B.   0.50 V.

C.   250 V.

D.   1 000 V.

32. The following are statements concerning radioactive decay.

      I.   Alpha particles have discrete energies.

      II.   The beta-energy spectrum is a broad continuous distribution of energies.

   III.   Gamma rays are emitted with discrete energies.

Which statement(s) is(are) evidence for the existence of nuclear energy levels?

A.   I only

B.   II only

C.   III only

D.   I and III only

33. When light is incident on a metal surface, electrons may be ejected. The following graph shows the variation with frequency f of the maximum kinetic energy $E_k\ max$ of the ejected electrons.
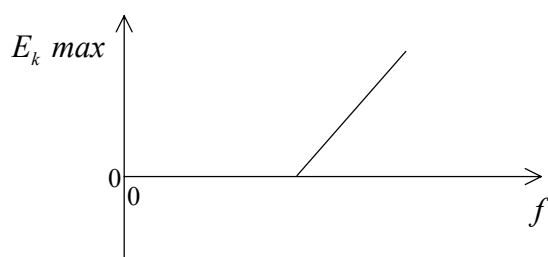
Which **one** of the following graphs best shows the variation with frequency f of the maximum kinetic energy $E_k\ max$ of the ejected electrons if another metal surface with a lower threshold frequency is used?

A.

B.

C.

D.
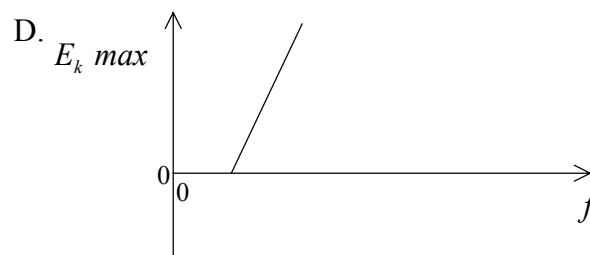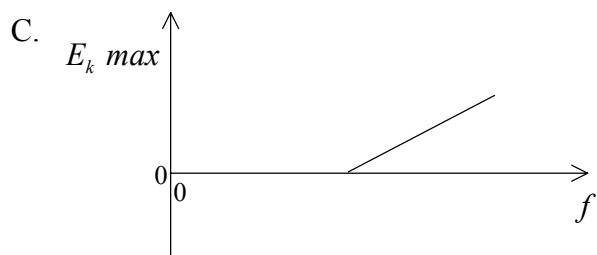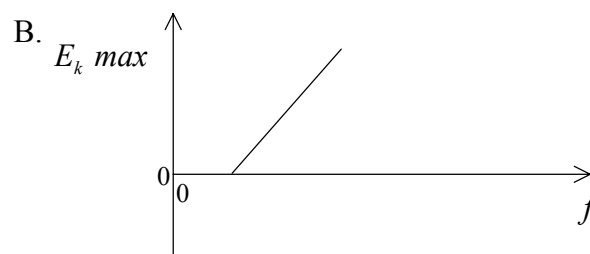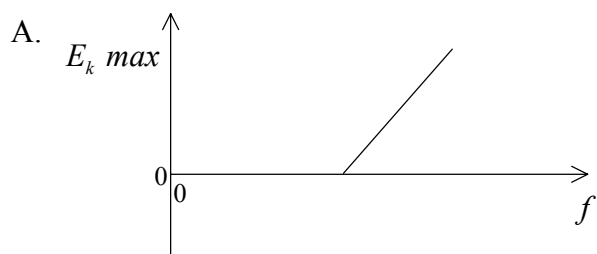
34. Some of the energy levels of the hydrogen atom are shown below.

$$
\begin{array}{ll}
\underline{\hspace{4cm}} & -\,0.54\ \text{eV} \\
\underline{\hspace{4cm}} & -\,0.85\ \text{eV} \\
\underline{\hspace{4cm}} & -\,1.51\ \text{eV} \\
\\
\underline{\hspace{4cm}} & -\,3.39\ \text{eV} \\
\\
\\
\\
\underline{\hspace{4cm}} & -\,13.6\ \text{eV}
\end{array}
$$
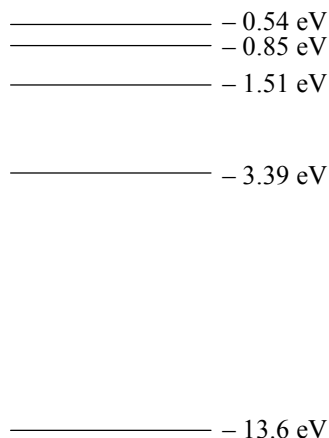
Electrons are excited to the 0.85 eV level. How many different photon frequencies will be observed in the emission spectrum of hydrogen?

A.   3

B.   4

C.   5

D.   6

35. When electrons of suitable energy travel through a thin layer of graphite, a pattern of concentric circles is produced on a screen.

fine beam of electrons $\longrightarrow\!\!\!\!\!\longrightarrow$

graphite   fluorescent screen
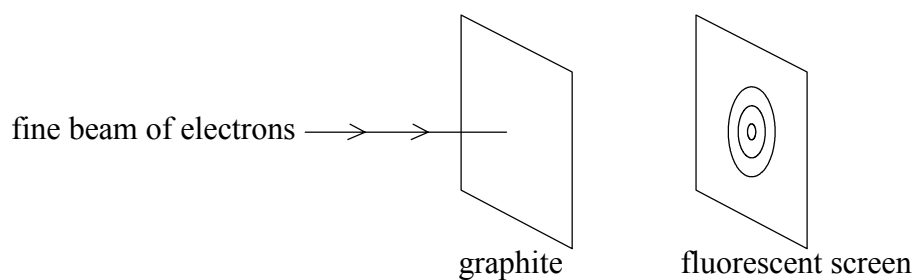
The production of this pattern is evidence for

A.   the wave nature of the electron.

B.   the nuclear model of the atom.

C.   the particle nature of the electron.

D.   the existence of X-rays.

36. X-rays can be produced by the collision of high energy electrons with

    A.   a metal.

   B.   a gas.

    C.   photons.

    D.   neutrinos.

37. In a mass spectrograph, ions of isotopes of the same element follow different semicircular paths in a uniform magnetic field as shown below.
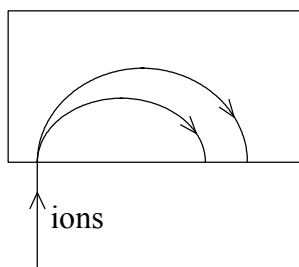
ions

The difference in path curvature is essentially due to the fact that the ions have different values of

    A.   charge only.

    B.   mass only.

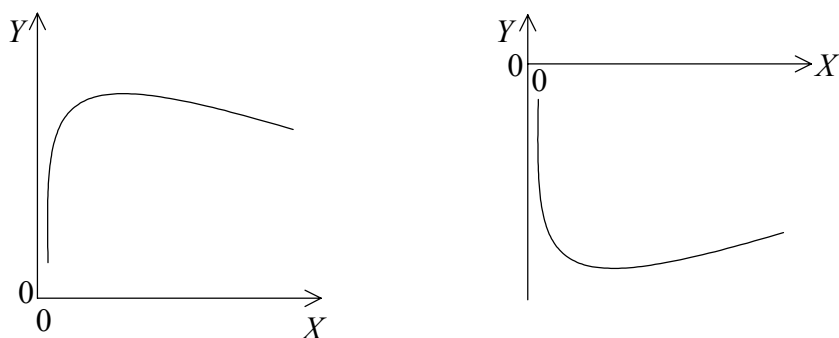   C.   mass and charge.

    D.   mass and speed.

38.   The activity of a sample of Iodine-131 is plotted as a function of time as shown below. The activity scale is logarithmic.
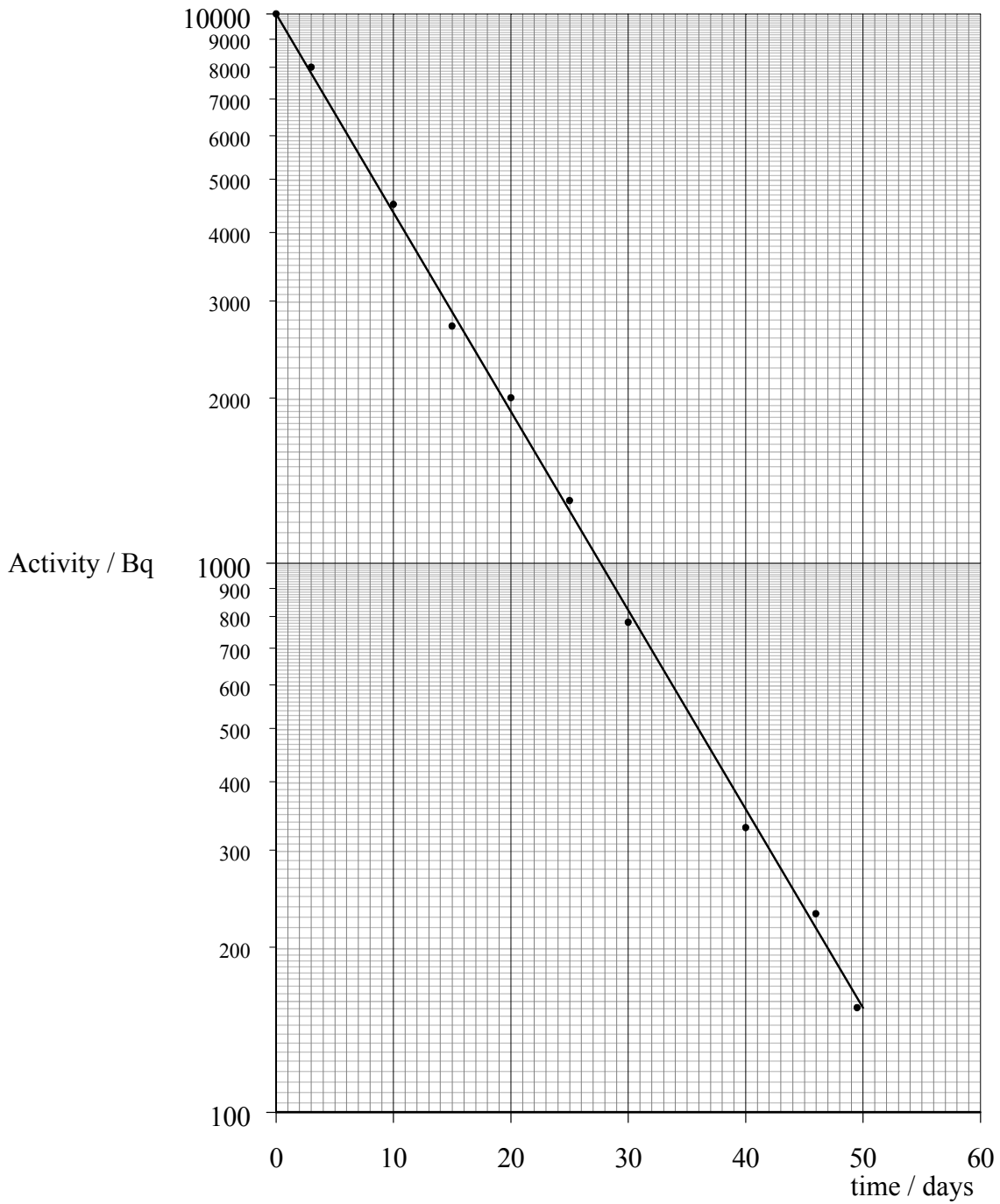
The half-life of Iodine-131 is close to

A.   180 days.

B.   55 days.

C.   28 days.

D.   8 days.

Turn over

39. Either of the two following graphs is useful in predicting nuclear energy changes in fission and fusion processes.

Which **one** of the following correctly identifies the quantities X and Y?

	X	Y
A.	atomic number	total binding energy
B.	mass number	total binding energy
C.	atomic number	average binding energy per nucleon
D.	mass number	average binding energy per nucleon

40. The reaction

$$n \rightarrow p + e^-$$
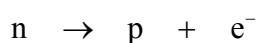
never occurs because it violates the law of conservation of

A.   baryon number only.

B.   lepton number only.

C.   electric charge only.

D.   baryon number and electric charge only.