



22066513

**PHYSICS
HIGHER LEVEL
PAPER 1**

Tuesday 9 May 2006 (afternoon)

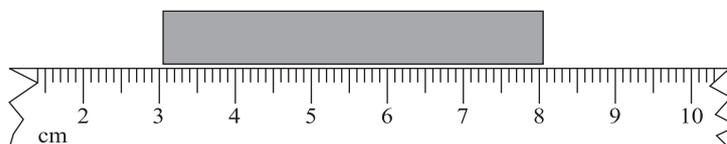
1 hour

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. The mass of an electron is 9.1×10^{-31} kg and that of a proton is 1.7×10^{-27} kg. Which **one** of the following is the difference in the order of magnitude of the masses of the electron and the proton?
- A. 10.8
 - B. 7.4
 - C. 5.4
 - D. 3

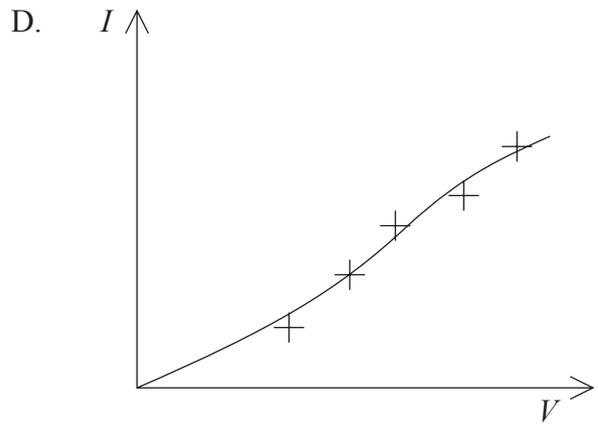
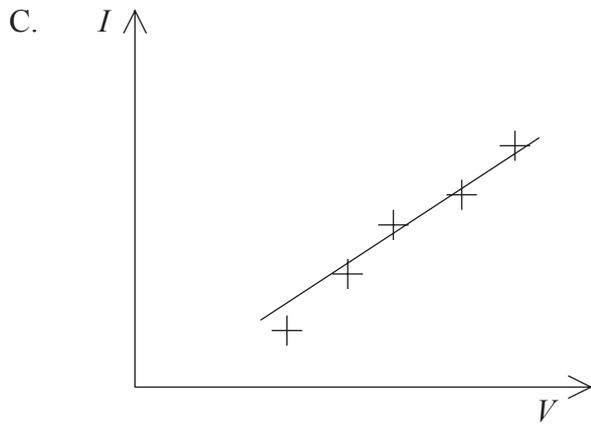
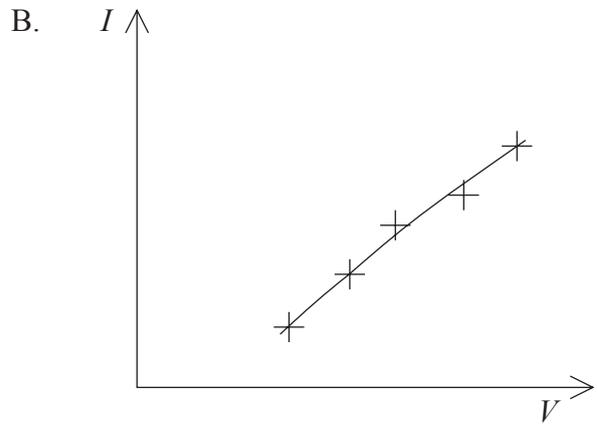
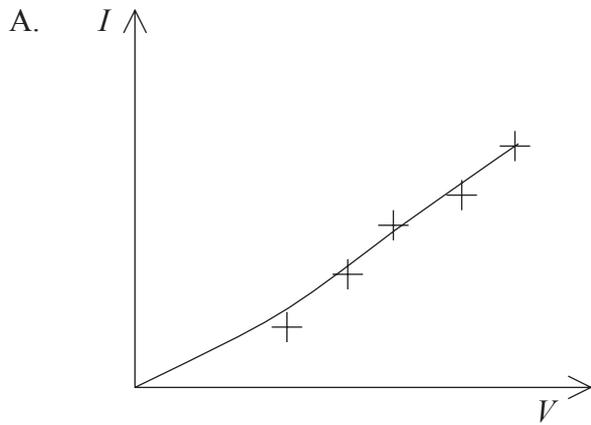
2. The length of a rod is measured using part of a metre rule that is graduated in millimetres, as shown below.



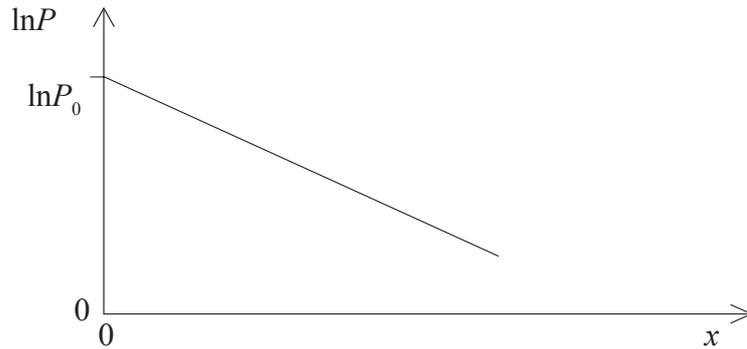
Which **one** of the following is the measurement, with its uncertainty, of the length of the rod?

- A. 5 ± 0.1 cm
- B. 5 ± 0.2 cm
- C. 5.0 ± 0.1 cm
- D. 5.0 ± 0.2 cm

3. Values of current I in an electrical component and of the corresponding potential difference V across the component are plotted on a graph. Error bars for each point have been included. Which **one** of the following shows the best-fit line for the plotted points?

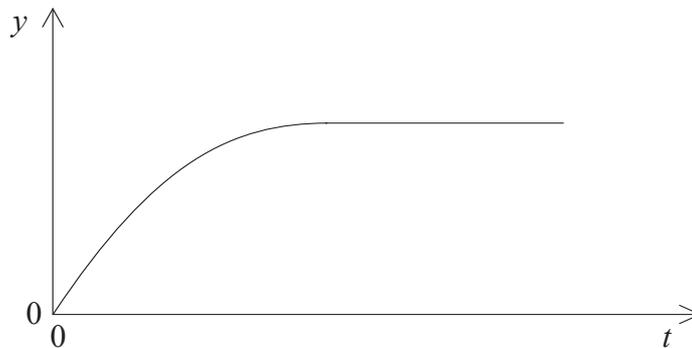


4. The graph below shows the variation with $\ln P$ of a quantity x . ($\ln P$ is the natural logarithm of the quantity P .) The magnitude of the gradient of the line is g .



Which **one** of the following is the correct expression for the variation of P with x ?

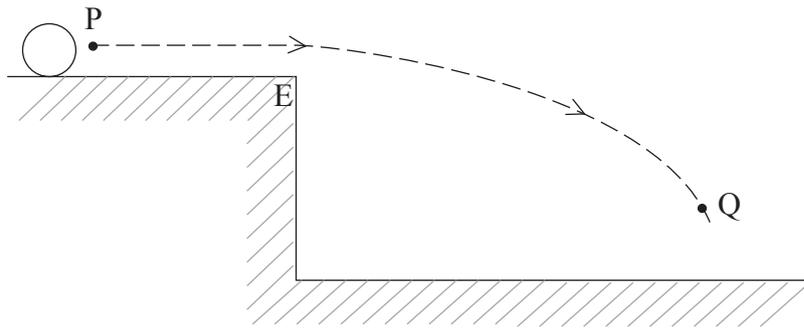
- A. $P = P_0 e^{-gx}$
 - B. $P = P_0 e^{+gx}$
 - C. $P = P_0 + e^{-gx}$
 - D. $P = P_0 - e^{+gx}$
5. The graph below shows how a quantity y varies with time t for a falling object.



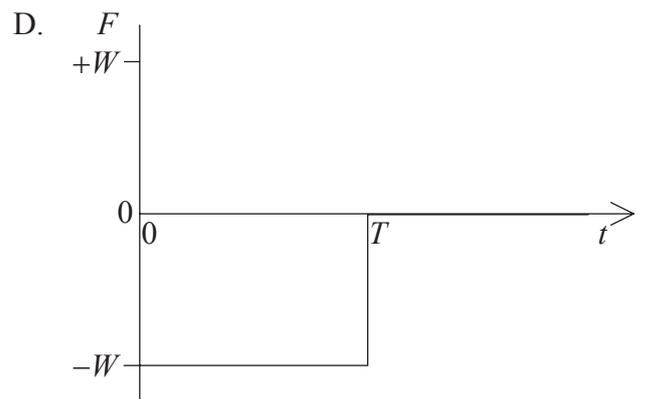
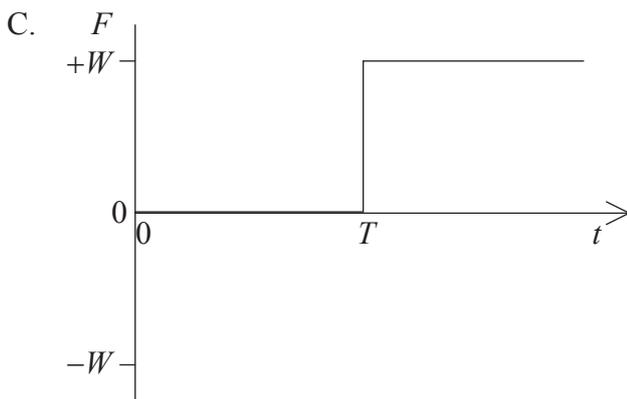
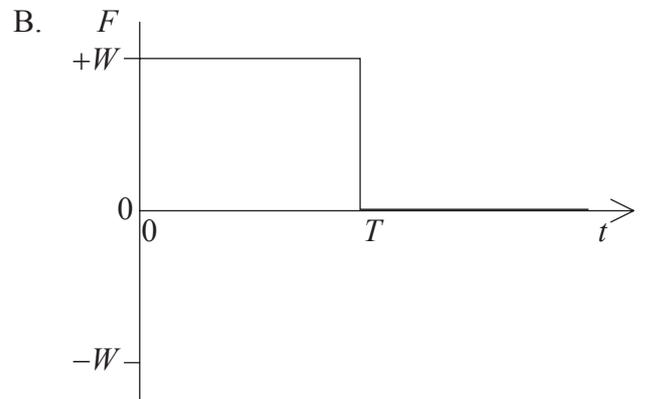
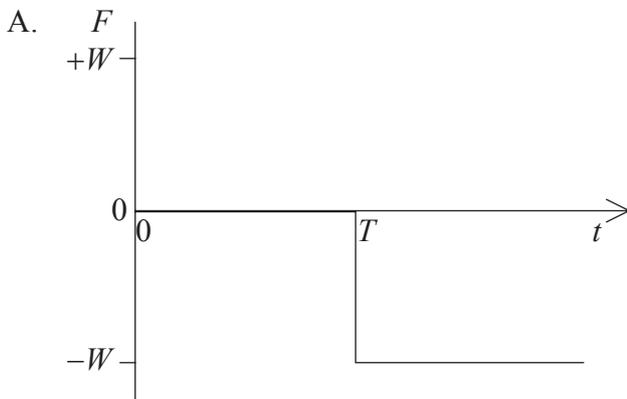
Which **one** of the following quantities could be represented by y ?

- A. Speed when air resistance is negligible
- B. Speed when air resistance is not negligible
- C. Distance moved from rest when air resistance is negligible
- D. Distance moved from rest when air resistance is not negligible

6. A ball of weight W slides along a frictionless surface as shown below.

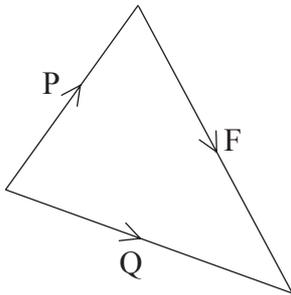


At time T , the ball has moved from point P to the edge E of the surface. The ball then falls freely to point Q. Which graph best shows the variation with time t of the **resultant upward** vertical force F acting on the ball between point P and point Q?

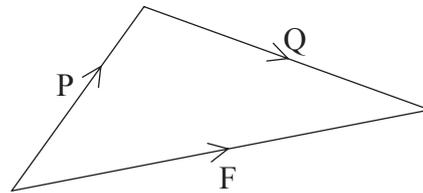


7. A block rests on a rough surface. Two forces P and Q act on the block, parallel to the surface. A friction force F between the block and the surface keeps the block in equilibrium. Which vector diagram best represents the three forces?

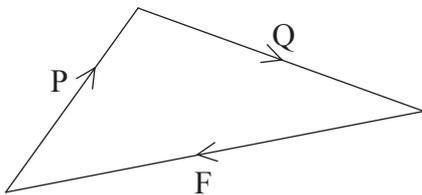
A.



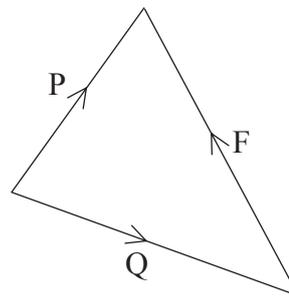
B.



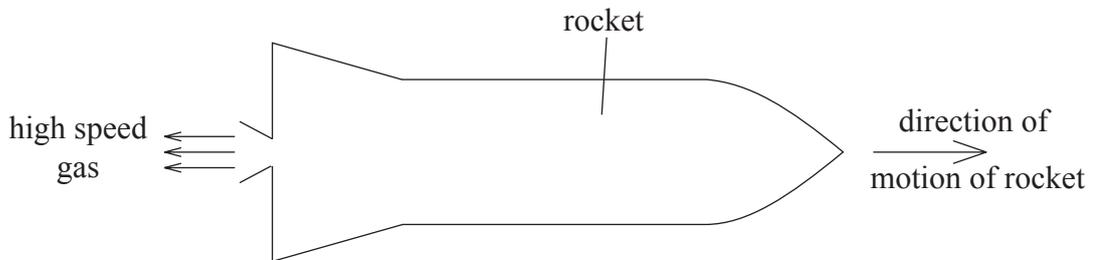
C.



D.



8. The engine of a rocket ejects gas at high speed, as shown below.



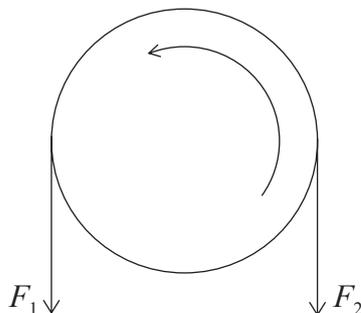
The rocket accelerates forwards because

- A. the momentum of the gas is equal but opposite in direction to the momentum of the rocket.
- B. the gas pushes on the air at the back of the rocket.
- C. the change in momentum of the gas gives rise to a force on the rocket.
- D. the ejected gas creates a region of high pressure behind the rocket.

9. A frictionless trolley of mass m moves down a slope with a constant acceleration a . A second similar frictionless trolley has mass $2m$. The acceleration of the second trolley as it moves down the slope is

- A. $\frac{1}{2}a$.
- B. a .
- C. $2a$.
- D. $4a$.

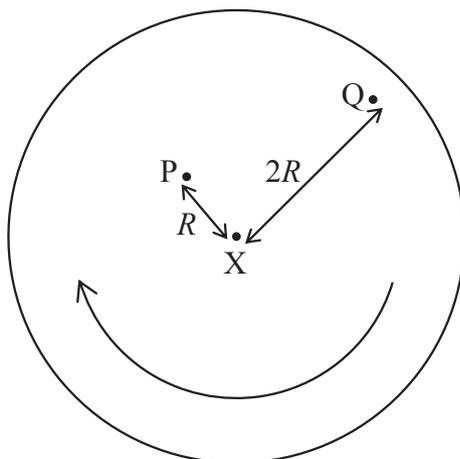
10. Forces of magnitude F_1 and F_2 act tangentially on the edge of a wheel of circumference S . The wheel is made to complete one revolution about its centre, in the direction shown below.



Which **one** of the following is a correct expression for the work done on the wheel?

- A. $F_1 \times S$
- B. $F_2 \times S$
- C. $(F_2 - F_1) \times S$
- D. $(F_2 + F_1) \times S$

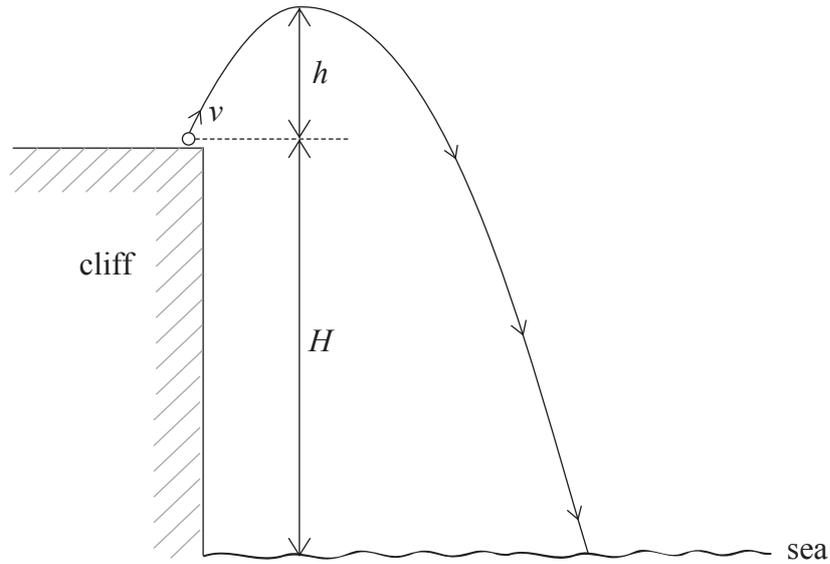
11. Points P and Q are at distances R and $2R$ respectively from the centre X of a disc, as shown below.



The disc is rotating about an axis through X, normal to the plane of the disc. Point P has linear speed v and centripetal acceleration a . Which **one** of the following is correct for point Q?

	Linear speed	Centripetal acceleration
A.	v	a
B.	v	$2a$
C.	$2v$	$2a$
D.	$2v$	$4a$

12. A stone is thrown with speed v from the top of a cliff of height H , as shown below.



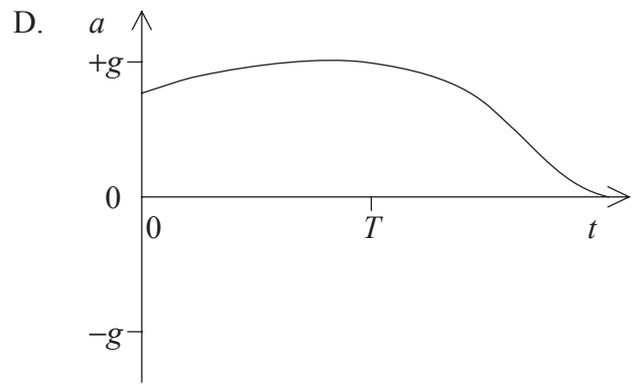
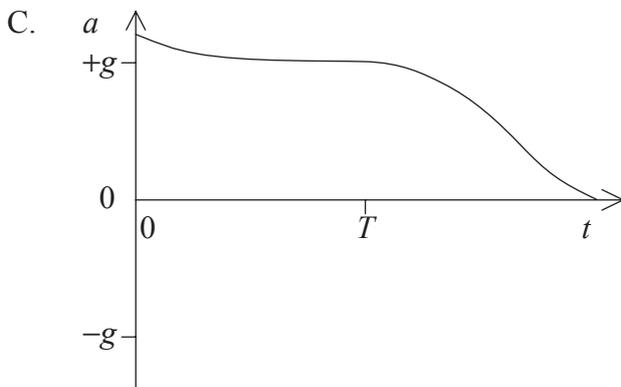
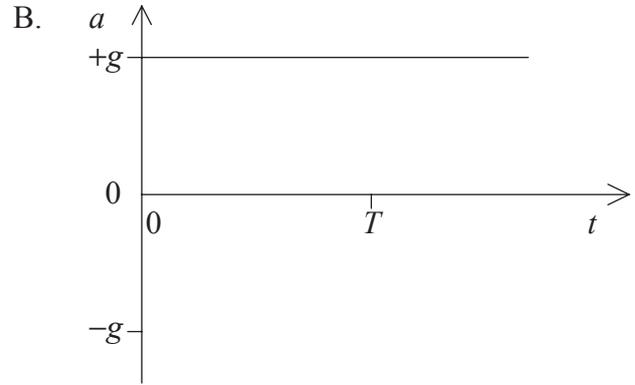
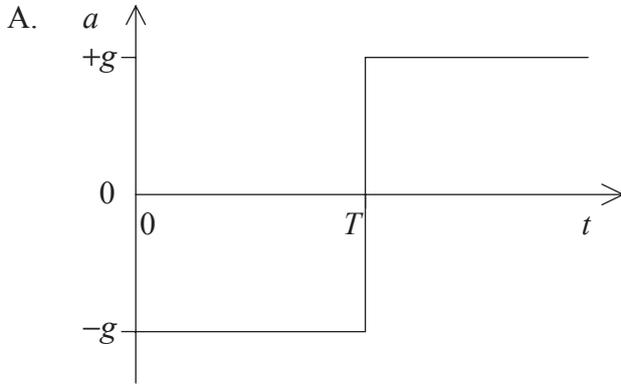
The stone is thrown at an angle to the horizontal so that it rises to a height h above the top of the cliff before falling into the sea. The acceleration of free fall is g . Air resistance is negligible.

Which **one** of the following expressions gives correctly the speed of the stone as it hits the sea?

- A. $v + \sqrt{2gh}$
 - B. $v + \sqrt{2gH}$
 - C. $\sqrt{2g\{h+H\}}$
 - D. $\sqrt{v^2 + 2gH}$
13. Which **one** of the following correctly relates the radius R of the circular orbit of planets about the Sun to the period T of the orbit?
- A. $T \propto R^2$
 - B. $T \propto R^3$
 - C. $T^2 \propto R^3$
 - D. $T^3 \propto R^2$

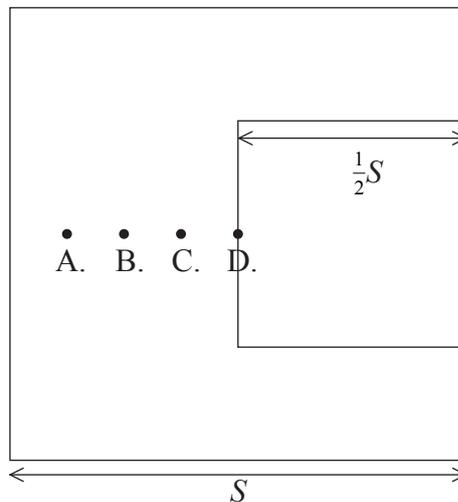
14. A ball is thrown vertically upwards at time $t = 0$. Air resistance is **not** negligible and the acceleration of free fall is g . The ball reaches a maximum height at time $t = T$ and then descends, reaching a terminal speed.

Which graph best shows the variation with time t of the acceleration a of the ball?

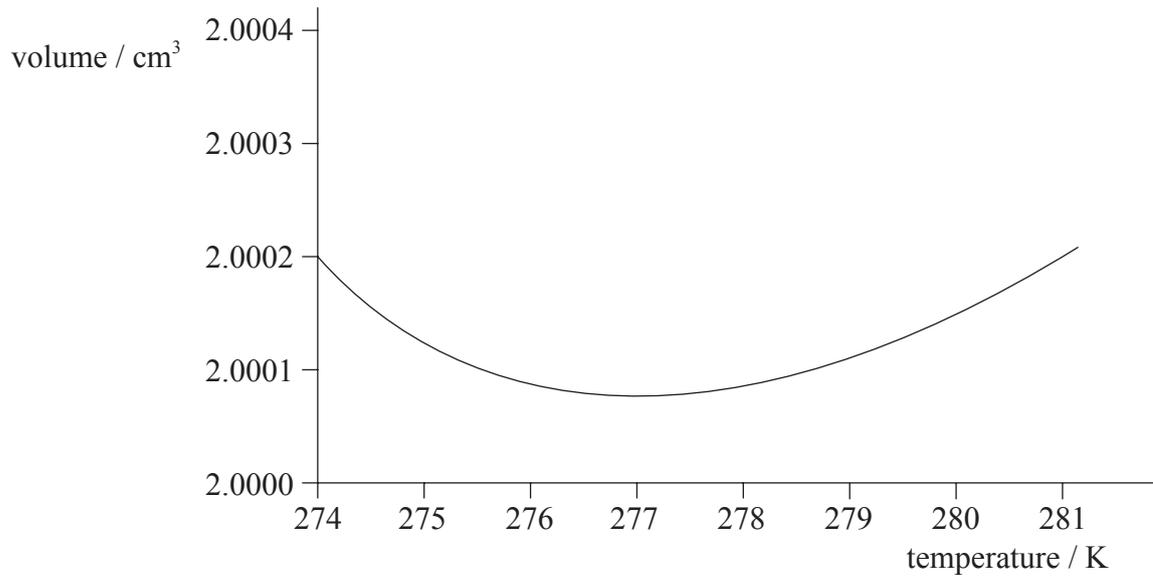


15. A square metal sheet of side S has constant thickness. A square of metal of side $\frac{1}{2}S$ is cut out of the sheet, as shown below.

Which **one** of the positions best indicates the new position of the centre of gravity of the sheet?



16. The graph below shows the variation with temperature of the volume of a fixed mass of water.



A thermometer is to be designed that measures temperatures in the range between 274 K and 280 K.

Which **one** of the following is the main reason why the variation with temperature of the volume of the water is not suitable to use in the thermometer?

- A. Water is a colourless liquid.
 - B. Water freezes at 273 K.
 - C. The change in volume is too small over the temperature range.
 - D. The volume has the same value at more than one temperature.
17. A lump of metal is initially at a temperature of 100°C . The metal is heated so that its temperature rises by θ degrees, as measured on the Celsius scale. The rise in temperature, as measured on the Kelvin scale is
- A. $\theta - 273$.
 - B. θ .
 - C. $\theta + 273$.
 - D. $\theta + 373$.

18. A large mass M of ice of specific latent heat L is at its melting point (0°C). A small mass m of water at $\theta^\circ\text{C}$ is poured on to the block of ice. The specific heat capacity of water is S . Which **one** of the following is a correct expression for the mass of ice melted?

A. $\frac{mL}{S\theta}$

B. $\frac{mS\theta}{L}$

C. $\frac{MS\theta}{L}$

D. $\frac{ML}{S\theta}$

19. The first law of thermodynamics may be expressed in terms of the quantities below.

ΔU , the **increase** in the internal energy of the system

Q , the energy transferred **to** the system by heating

W , the work done **on** the system

Which **one** of the following is a correct statement of the law?

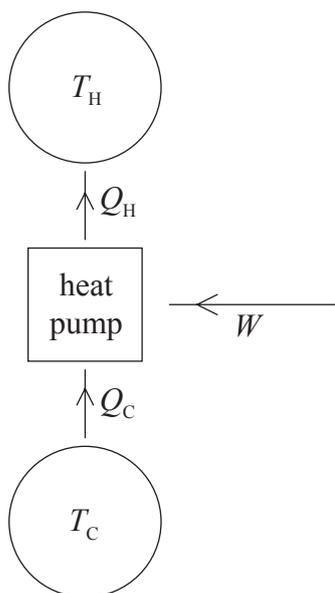
A. $W = \Delta U + Q$

B. $W = -\Delta U - Q$

C. $W = \Delta U - Q$

D. $W = -\Delta U + Q$

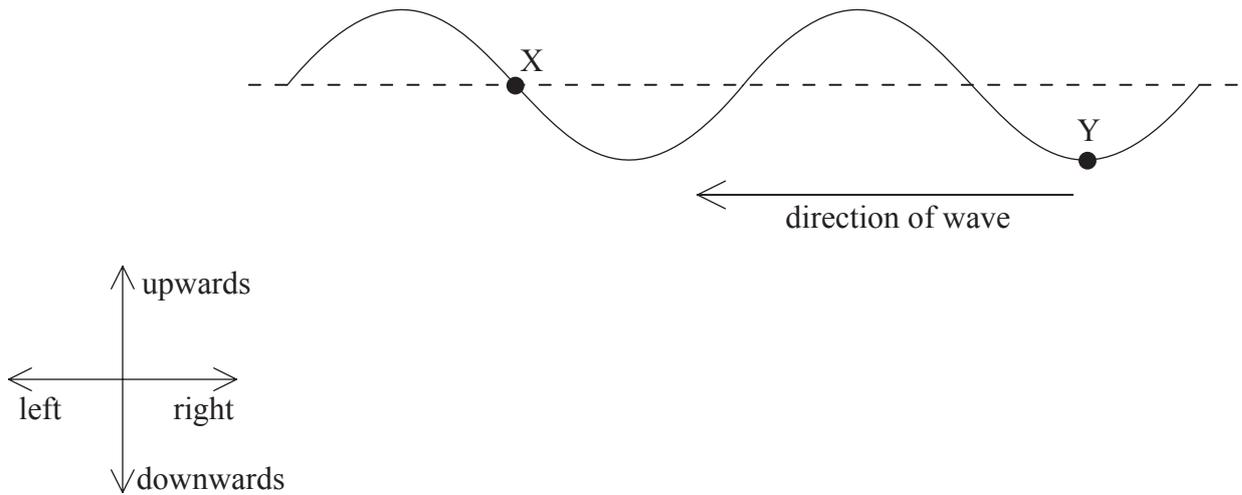
20. The diagram below shows energy transfers in a heat pump operating between two reservoirs at temperatures T_H and T_C ($T_H > T_C$).



Which of the following gives the correct relationship between W , Q_C and Q_H ?

- A. $W > Q_H - Q_C$
- B. $W < Q_H - Q_C$
- C. $W = Q_H - Q_C$
- D. $W = Q_H + Q_C$

21. The diagram below shows a transverse wave on a string. The wave is moving from right to left.



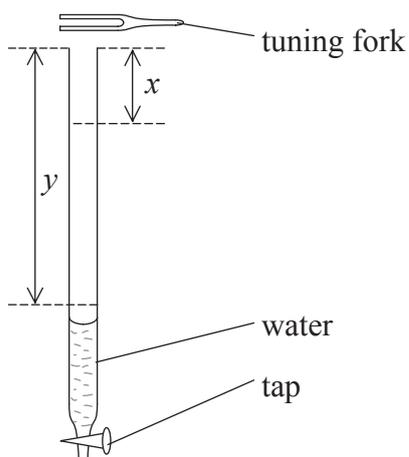
In the position shown, point X has zero displacement and point Y is at a position of maximum displacement. Which **one** of the following gives the subsequent direction of motion of point X and of point Y?

	Point X	Point Y
A.	left	left
B.	upwards	upwards
C.	downwards	left
D.	downwards	upwards

22. Which **one** of the following correctly describes the change, if any, in the speed, wavelength and frequency of a light wave as it passes from air into glass?

	Speed	Wavelength	Frequency
A.	decreases	decreases	unchanged
B.	decreases	unchanged	decreases
C.	unchanged	increases	decreases
D.	increases	increases	unchanged

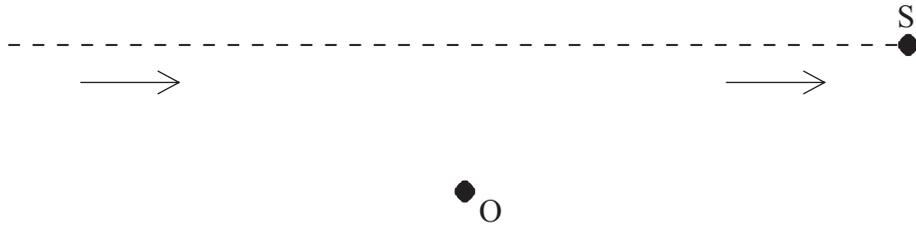
23. A tube is filled with water and a vibrating tuning fork is held above its open end.



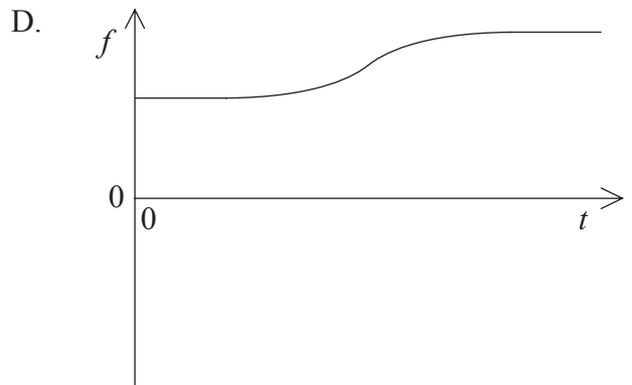
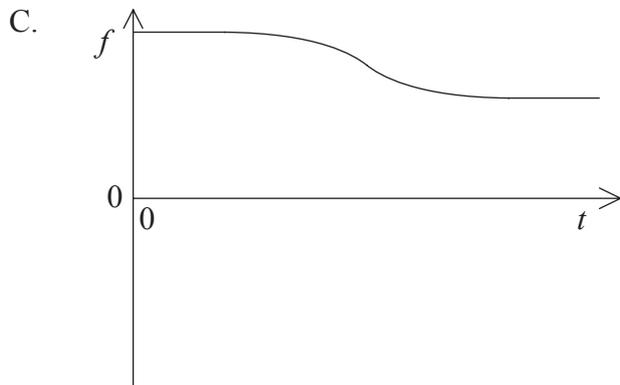
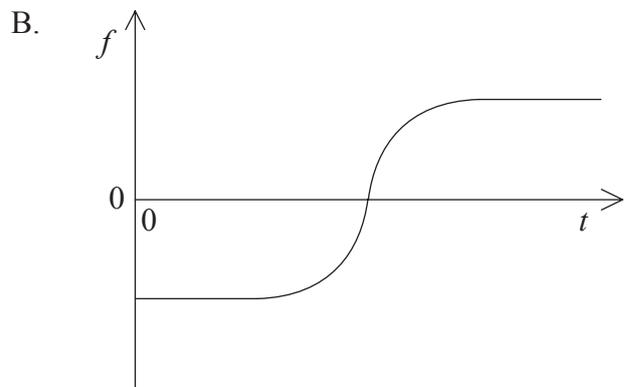
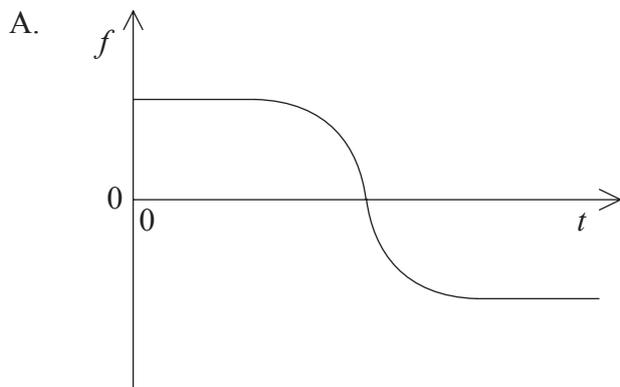
The tap at the base of the tube is opened. As the water runs out, the sound is loudest when the water level is a distance x below the top of the tube. A second loud sound is heard when the water level is a distance y below the top. Which **one** of the following is a correct expression for the wavelength λ of the sound produced by the tuning fork?

- A. $\lambda = y$
- B. $\lambda = 2x$
- C. $\lambda = y - x$
- D. $\lambda = 2(y - x)$

24. A source S, moving at constant speed, emits a sound of constant frequency. The source passes by a stationary observer O, as shown below.



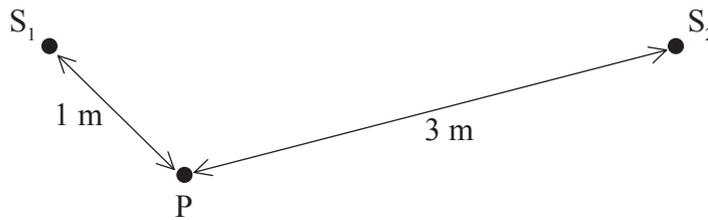
Which **one** of the following shows the variation with time t of the frequency f observed at O as the source S approaches and passes by the observer.



25. A tuning fork produces a note of frequency 412 Hz. Which **one** of the following gives the frequency heard, and the beat frequency, when a second fork of frequency 414 Hz is sounded together with the fork of frequency 412 Hz?

	Frequency heard / Hz	Beat frequency / Hz
A.	412	2
B.	413	1
C.	413	2
D.	414	1

26. Water waves of wavelength 2.0 m are produced by two sources S_1 and S_2 . The sources vibrate in phase.



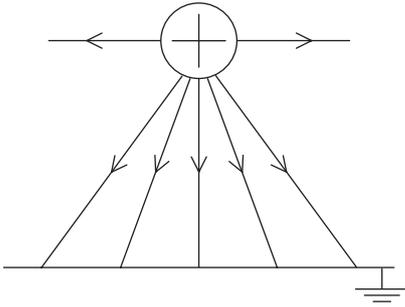
Point P is 1 m from S_1 and 3 m from S_2 . S_1 alone and S_2 alone each produce a wave of amplitude a at P . Which **one** of the following is the amplitude of the resultant wave at point P when S_1 and S_2 are both emitting waves?

- A. $2a$
- B. a
- C. $\frac{1}{2}a$
- D. Zero
27. Two point charges of magnitude $+2Q$ and $-Q$ are fixed at the positions shown below. At which point is the electric field due to the two charges most likely to be zero?

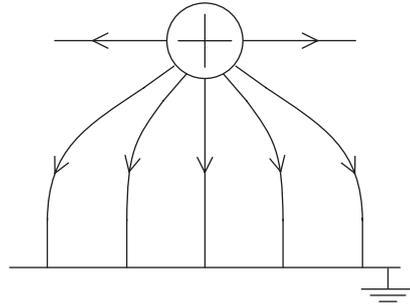


28. Which diagram below best represents the electric field pattern between a positively charged conducting sphere and an earthed metal plate?

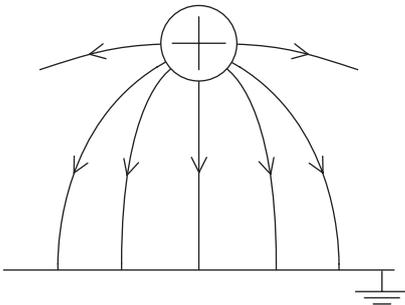
A.



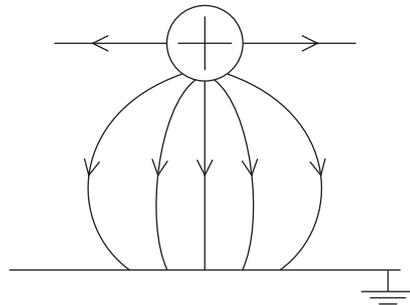
B.



C.

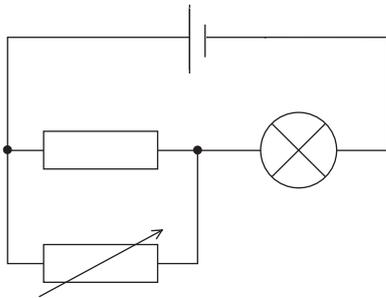


D.

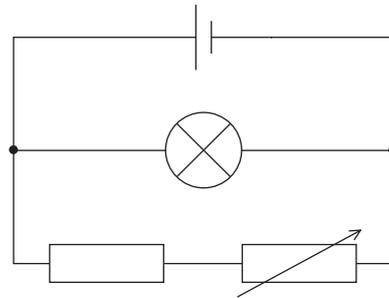


29. In which **one** of the circuits below is it possible to vary the current in the lamp by adjusting the variable resistor? The cell has negligible internal resistance.

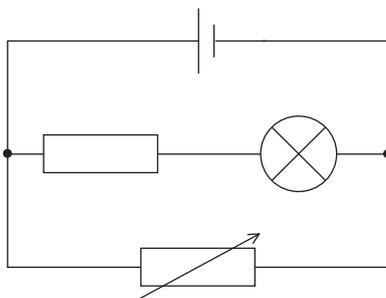
A.



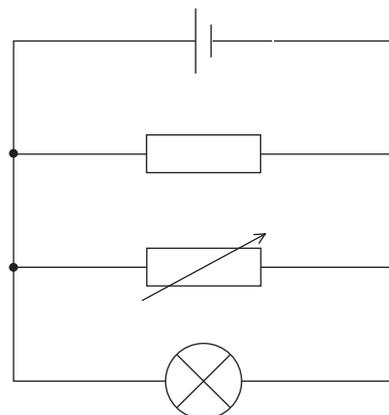
B.



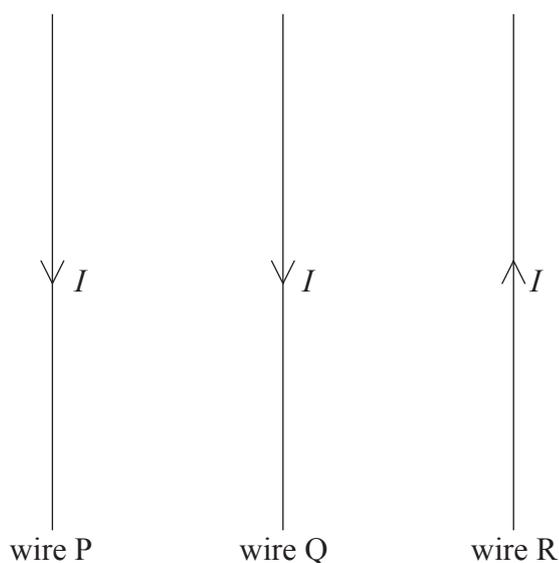
C.



D.



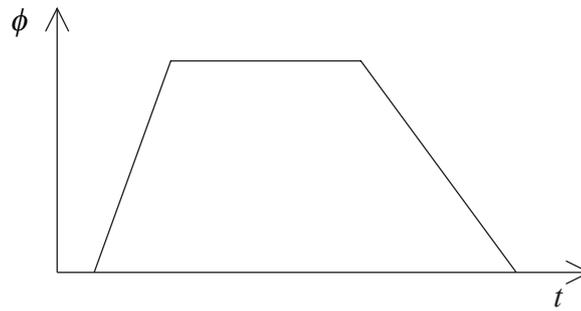
30. The diagram below shows three parallel wires P, Q and R that are equally spaced.



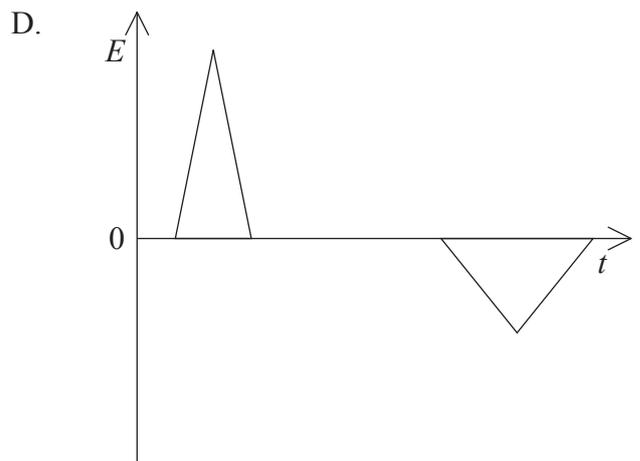
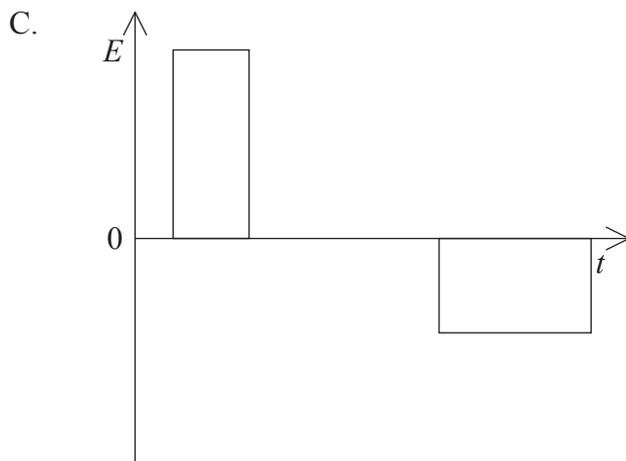
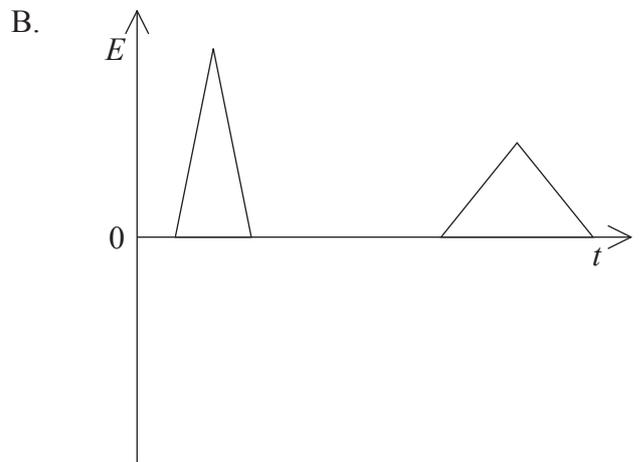
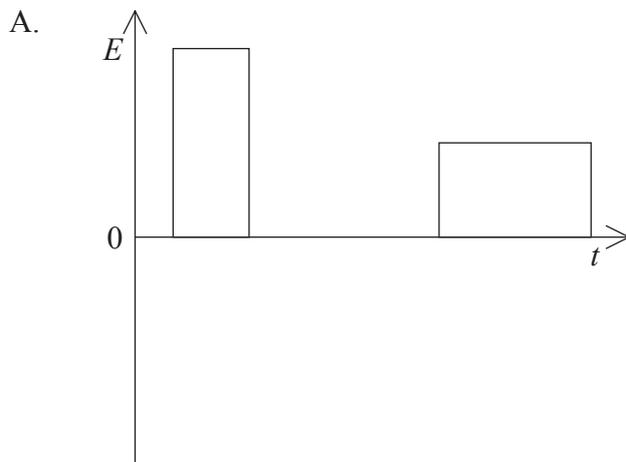
The currents in the wires are each of the same magnitude I and are in the directions shown. The resultant force on wire Q due to the current in wire P and in wire R is

- A. perpendicular and into the plane of the paper.
 - B. perpendicular and out of the plane of the paper.
 - C. in the plane of the paper to the right.
 - D. in the plane of the paper to the left.
31. Which **one** of the following statements about electric potential gradient is correct?
- A. Electric potential gradient is numerically equal to the gradient of the electric field.
 - B. Electric potential gradient at a point is numerically equal to the electric field strength at that point.
 - C. When one joule of work is done in moving one coulomb of charge between two points, the electric potential gradient between the points is one volt per metre.
 - D. When one joule of work is done in moving one coulomb of charge to a point, the electric potential gradient at that point is one volt per metre.

32. The magnetic flux ϕ in a coil varies with time t as shown below.



Which graph best represents the variation with time t of the e.m.f. E induced in the coil?

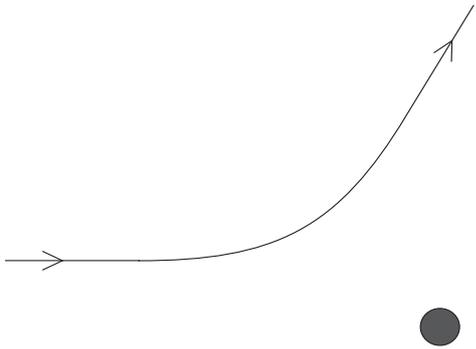


33. An alternating supply of constant r.m.s. current and constant r.m.s. potential difference is connected to the primary coil of an ideal transformer. Which **one** of the following describes the effect, if any, on the r.m.s. current and on the r.m.s. power in the circuit of the secondary coil when the number of turns on the secondary coil is increased?

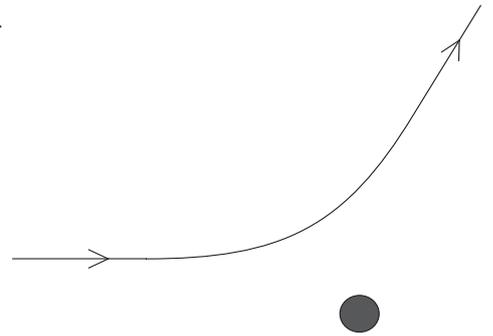
	r.m.s. current	r.m.s. power
A.	no change	increases
B.	no change	no change
C.	decreases	increases
D.	decreases	no change

34. Which **one** of the following best shows a possible path of an α -particle as it is deflected by a stationary gold nucleus?

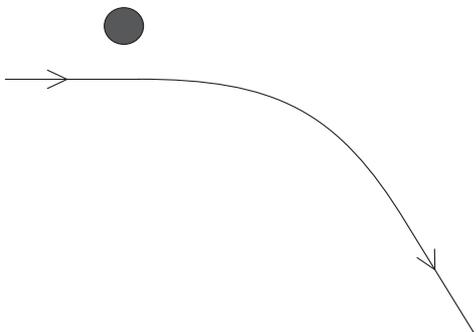
A.



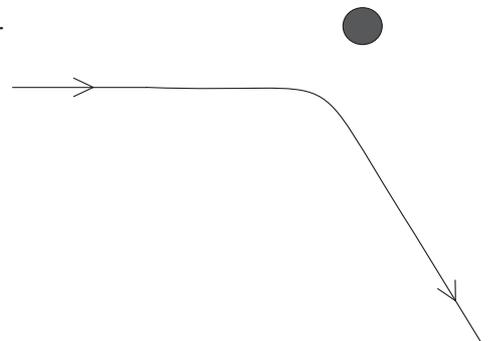
B.



C.



D.



35. A sample of a radioactive isotope of half-life $T_{\frac{1}{2}}$ initially contains N atoms. Which **one** of the following gives the number of atoms of this isotope that have **decayed** after a time $3T_{\frac{1}{2}}$?

A. $\frac{1}{8}N$

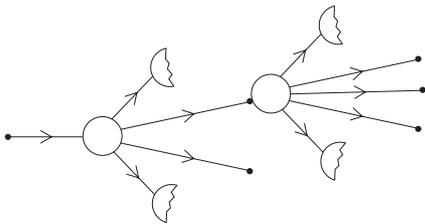
B. $\frac{1}{3}N$

C. $\frac{2}{3}N$

D. $\frac{7}{8}N$

36. Which **one** of the following diagrams best illustrates the first two stages of an uncontrolled fission chain reaction?

A.



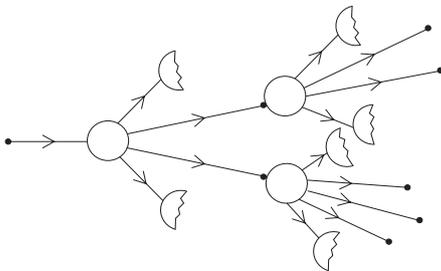
Key:

• neutron

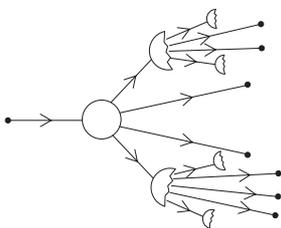
○ uranium nucleus

☾ fission fragment

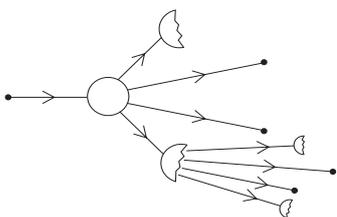
B.



C.



D.



37. In an experiment to investigate the photoelectric effect, monochromatic light is incident on a metal surface. The photoelectric current and the maximum kinetic energy of the photoelectrons are measured.

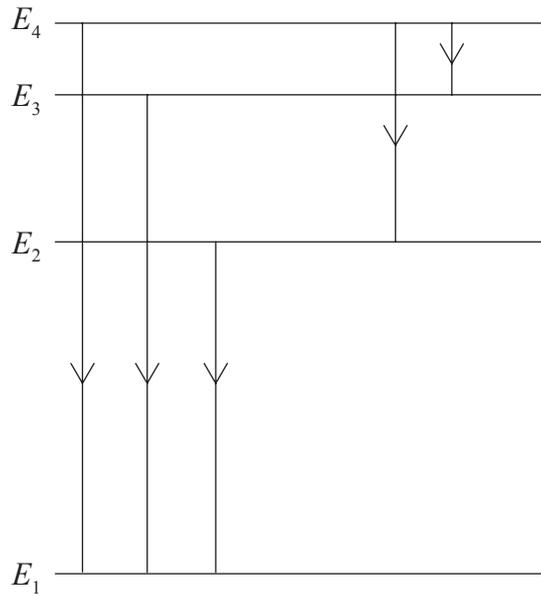
Which **one** of the following correctly shows the change, if any, in the photoelectric current and in the maximum kinetic energy of the photoelectrons when light of the same intensity but higher frequency is incident on the same metal surface?

	Photoelectric current	Maximum kinetic energy
A.	decreases	no change
B.	decreases	increases
C.	no change	decreases
D.	no change	increases

38. The decay constant of a radioactive isotope is 0.02 s^{-1} . Which **one** of the following statements about this isotope is true?

- A. The half-life of the isotope is $\frac{1}{0.02}$ s.
- B. In 1 s, 0.02 nuclei will decay.
- C. A nucleus decays in every 0.02 s.
- D. The probability that a nucleus will decay in 1 s is 0.02.

39. The diagram below shows four energy levels in an atom, together with some possible electron transitions.



Which **one** of the following best represents the emission line spectrum produced from these transitions?

- increasing wavelength
→
- A.
- B.
- C.
- D.

40. Which **one** of the following lists the exchange particles associated with quarks and with hadrons?

	Particles exchanged between quarks	Particles exchanged between hadrons
A.	leptons	mesons
B.	gluons	leptons
C.	mesons	gluons
D.	gluons	mesons
