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

PHYSICS
# HIGHER LEVEL
PAPER 1

Wednesday 2 May 2007 (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 grid below shows one data point and its associated error bar on a graph. The *x*-axis is not shown.
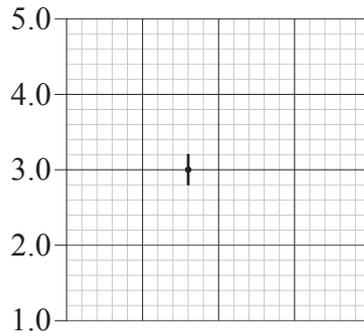
Which of the following is the correct statement of the *y*-value of the data point, with its uncertainty?

A. 3 ± 0.2

B. 3.0 ± 0.2

C. 3.0 ± 0.20

D. 3.00 ± 0.20

2. Three forces *F*, *T* and *W* act at a point P as shown below.
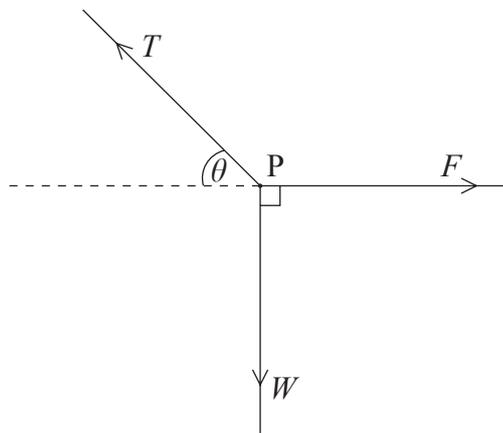
Which of the following gives the condition for point P to be in equilibrium?

A. $W = F \tan\theta$

B. $W = F \cos\theta$

C. $F = W \tan\theta$

D. $F = W \cos\theta$

3.   Quantity x varies with quantity y according to the expression

$$y = px^n,$$

where p and n are constants.

Values of $\lg x$ ($\log_{10} x$) are plotted against the corresponding values of $\lg y$ as shown below.
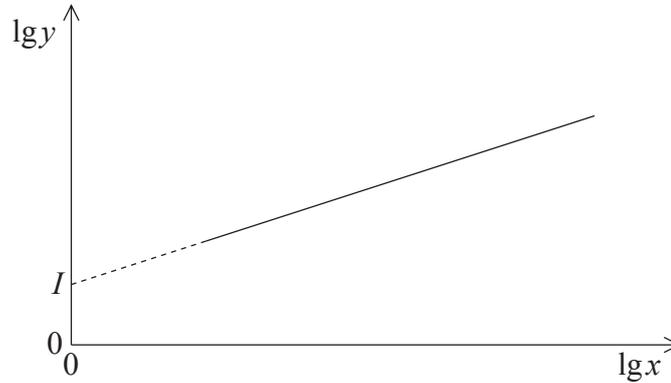
The intercept on the $\lg y$-axis is I. Which of the following gives the value of $\lg p$?

A. $-I$

B. $+I$

C. $-\lg I$

D. $+\lg I$

4.   An object has initial speed u and acceleration a. After travelling a distance s, its final speed is v. The quantities u, v, a and s are related by the expression

$$v^2 = u^2 + 2as.$$

Which of the following includes the **two** conditions necessary for the equation to apply?

|		
A.	a has constant direction	u and v are in the same direction
B.	a has constant direction	a, u and v are in the same direction
C.	a has constant magnitude	a has constant direction
D.	a has constant magnitude	u and v are in the same direction

5.   Two forces P and Q act at a point X. The individual forces are represented in magnitude and direction in the diagram below.
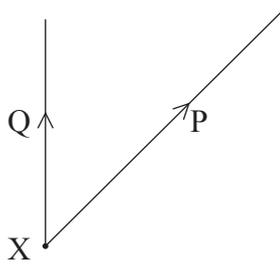
Which of the following diagrams best shows the value of S, where $S=(P-Q)$?

A.
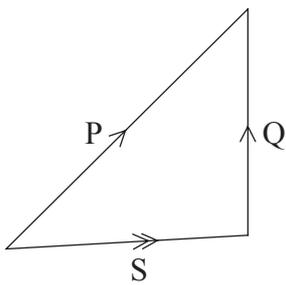
B.
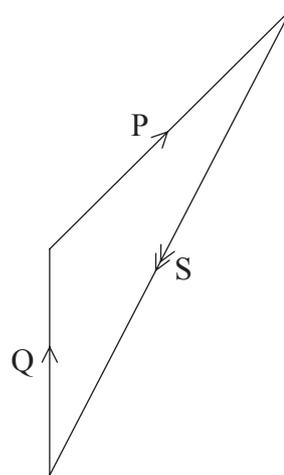
C.
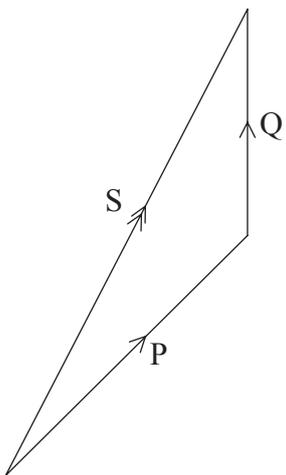
D.
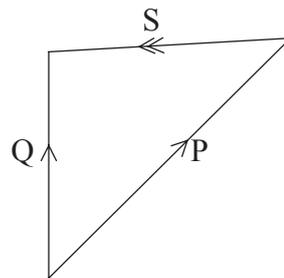
6. A rocket is moving through space. The rocket engine ejects a mass m of exhaust gases in time t. The speed of the exhaust gases, relative to the rocket, is v as shown below.
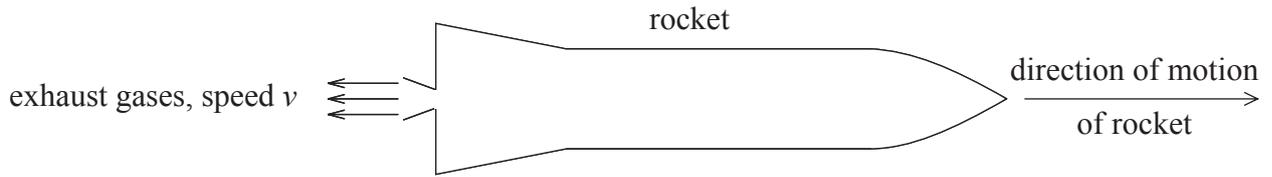
Which of the following expressions is the magnitude of the force exerted on the rocket by the exhaust gases?

A. mv

B. mv^2

C. mvt

D. $\dfrac{mv}{t}$

**7.** An object is suspended from the roof of a lift (elevator) as shown below.
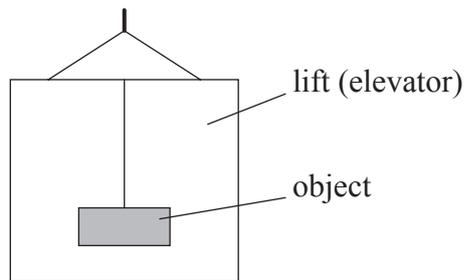
When the lift is moving upwards at **constant speed**, the weight of the object is W and its mass is M.

Which of the following correctly gives the mass and the weight of the object as the lift is **accelerating upwards**?

	Mass	**Weight**
A.	M	W
B.	M	greater than W
C.	greater than M	W
D.	greater than M	greater than W

8. The graph below shows the variation with displacement x of the force F acting on an object. The force F always acts in the same direction as the displacement.
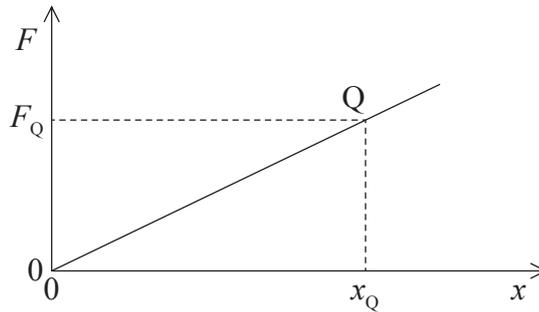

At point Q, the displacement is x_Q and the force is F_Q.

Which of the following gives the work done by the force on the body as the displacement increases from zero to x_Q and then returns to zero?

A.   Zero

B. $\frac{1}{2}F_Q x_Q$

C. $F_Q x_Q$

D. $2F_Q x_Q$

**9.**   Water flows out from a tank down a pipe, as shown below.

The pipe is always full of water.

Which of the following gives the change in the kinetic energy and in the gravitational potential energy of the water as the water flows down the pipe?

	kinetic energy	**gravitational potential energy**
A.	constant	decreases
B.	constant	increases
C.	increases	decreases
D.	increases	increases

10. A petrol engine P is used to drive a generator G. The energy-flow diagram for this system is shown below.
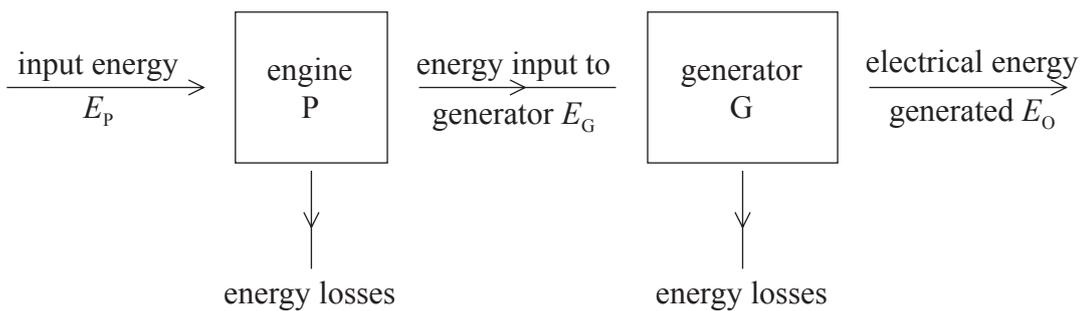
What is the efficiency of this electrical energy generating system?

A. $\dfrac{E_G}{E_P}$

B. $\dfrac{E_O}{E_P}$

C. $\dfrac{E_O}{E_G}$

D. $\dfrac{(E_O + E_G)}{E_P}$

11. In a fairground ride, a car of mass M travels on rails around a vertical loop of effective radius R. At the top of the loop, the speed of the car is v. The car stays in contact with the rails, as shown below.
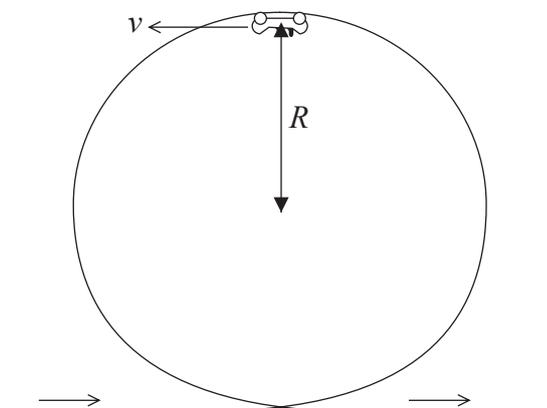

The acceleration of free fall is g.

Which of the following is the correct expression for the force that the rails exert on the car?

A. $\dfrac{Mv^2}{R} - Mg$

B. $\dfrac{Mv^2}{R}$

C. Mg

D. $\dfrac{Mv^2}{R} + Mg$

Turn over

12. Two identical metal spheres X and Y are released at the same time from the same height above the horizontal ground. Sphere X falls vertically from rest. Sphere Y is projected horizontally as shown below.
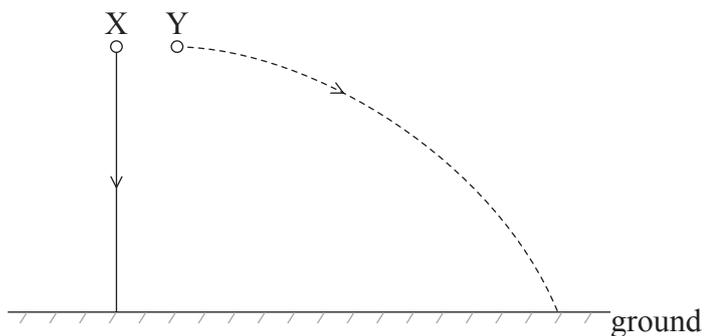

Air resistance is negligible.

Which of the following statements is correct?

A. Sphere X hits the ground before sphere Y because it travels a shorter distance.

B. Sphere Y hits the ground before sphere X because its initial velocity is greater.

C. The spheres hit the ground at the same time because horizontal motion does not affect vertical motion.

D. The spheres hit the ground at the same time because they have equal weights.

13. Two isolated spheres of masses M and m are held a distance d apart, as shown below.
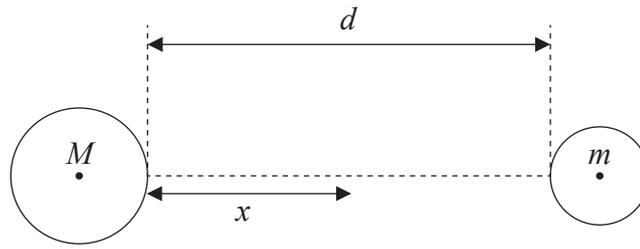
Mass M is greater than mass m.

The gravitational field strength g is measured on a line between the two masses. Which graph best shows the variation with distance x from the larger sphere of the magnitude of the field strength g? The Earth's gravitational field is to be ignored.

A.

B.

C.

D.
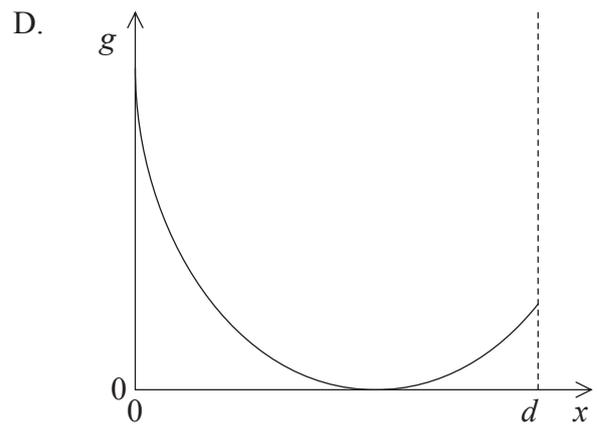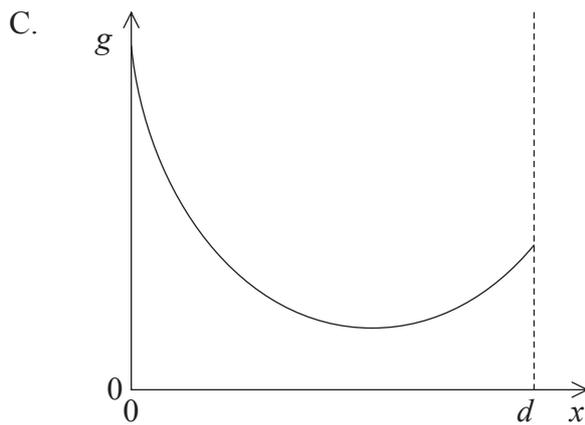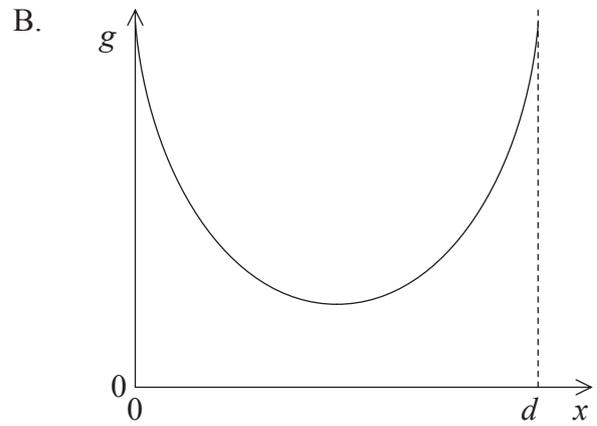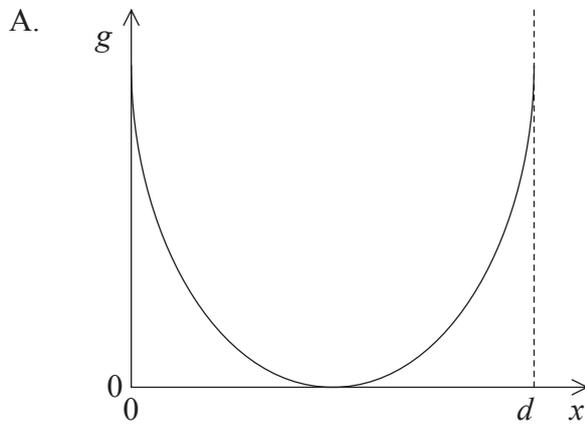
14. The escape speed from a planet is defined as the speed at which an object must leave the planet's surface to

   A.   escape completely from the gravitational field of the planet.

   B.   enter a geostationary orbit about the planet.

   C.   escape from the atmosphere of the planet.

   D.   overcome the gravitational force of the planet.

15. A planet is in a circular orbit of radius r about a star. The period of the planet in its orbit is T.
A second planet orbits the same star in a circular orbit of radius r_S.

Which of the following is a correct expression for the period of the second planet in its orbit about the star?

   A. $\left(\dfrac{r_S}{r}\right)^3 T^2$

   B. $\left(\dfrac{r_S}{r}\right)^{\frac{3}{2}} T$

   C. $\left(\dfrac{r_S}{r}\right)^2 T^3$

   D. $\left(\dfrac{r_S}{r}\right) T^{\frac{3}{2}}$

16. A block of weight W rests on a horizontal surface as shown below.
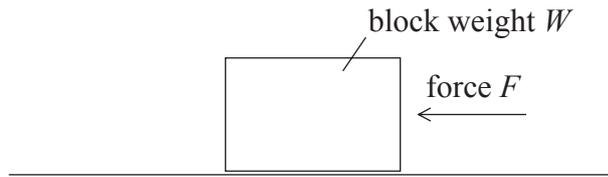

A horizontal force F acts on the block and is slowly increased from zero until the block begins to move. The coefficient of static friction is μ_S and of dynamic friction is μ_D.

Which of the following is the magnitude of the maximum frictional force between the block and the surface?

A. $(\mu_S - \mu_D)W$

B. $\mu_S W$

C. $\mu_D W$

D. $(\mu_S + \mu_D)W$

17. An uneven rod is supported from a peg by means of a string. The friction force between the peg and the string is negligible.

Which of the points best shows the position of the centre of gravity of the rod?
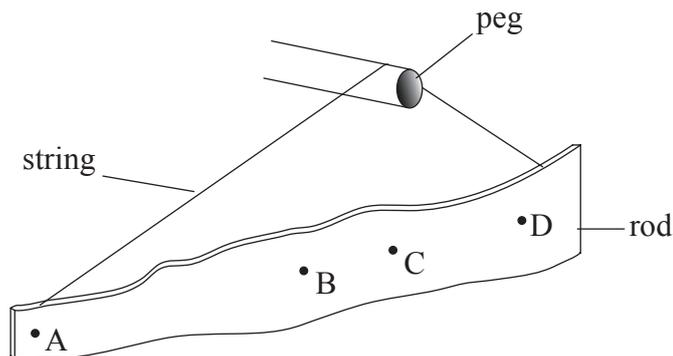
18. The length of the mercury column in a thermometer is L_{100} at $100\,°C$ and L_0 at $0\,°C$.

Which of the following gives the temperature when the length of the mercury column is L_T?

A. $\dfrac{L_T}{L_{100}} \times 100\,°C$

B. $\dfrac{L_T}{(L_{100} - L_0)} \times 100\,°C$

C. $\dfrac{(L_{100} - L_T)}{(L_{100} - L_0)} \times 100\,°C$

D. $\dfrac{(L_T - L_0)}{(L_{100} - L_0)} \times 100\,°C$

19. A metal block of mass M is heated. The graph shows the variation with thermal energy H supplied to the block of its temperature rise θ.
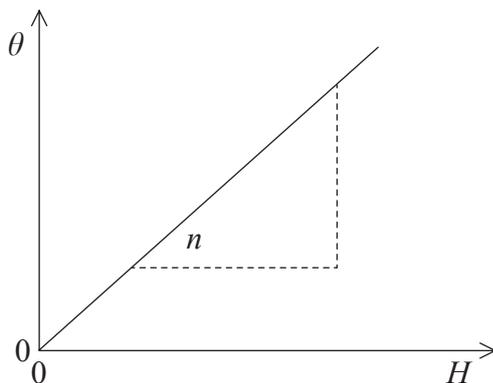

The gradient of the straight-line graph is n. The specific heat capacity of the metal is

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

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

C. Mn.

D. n.

20. Which of the following pressure-volume (p-V) diagrams best represents a Carnot cycle?

A.

B.

C.

D.
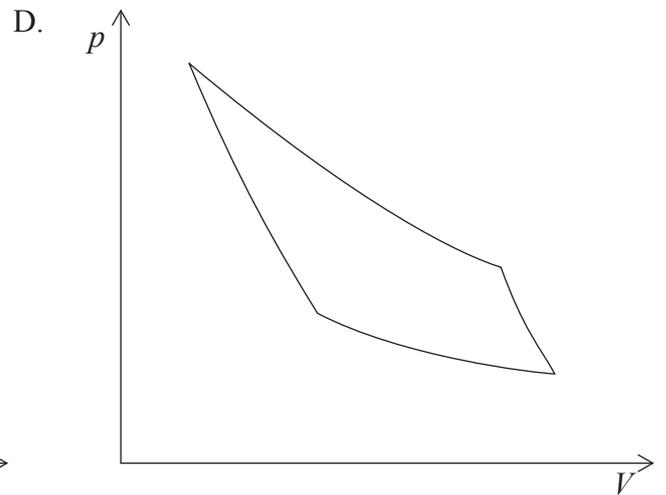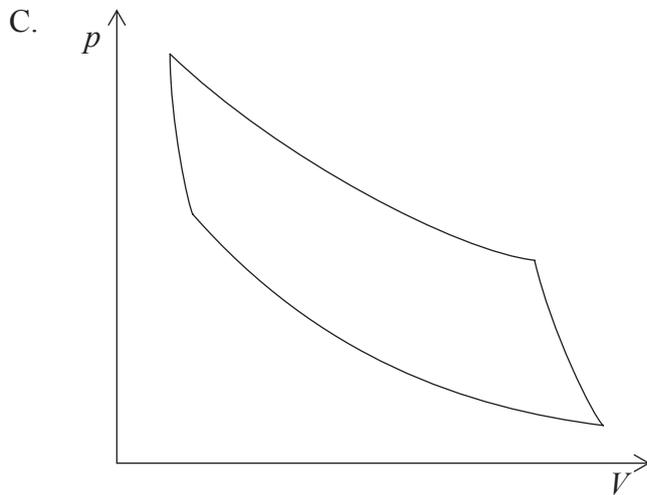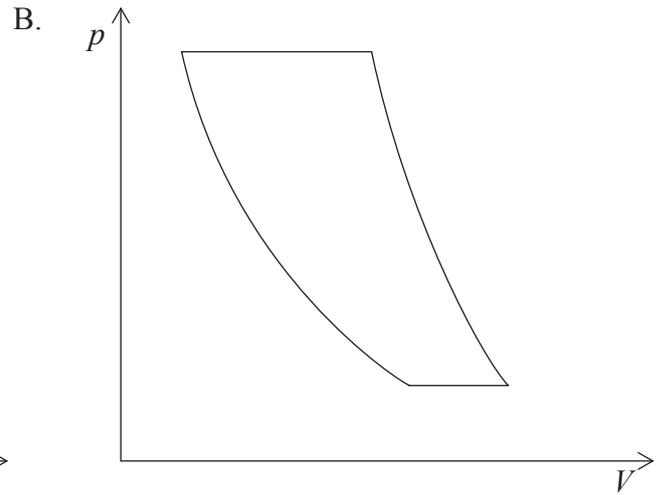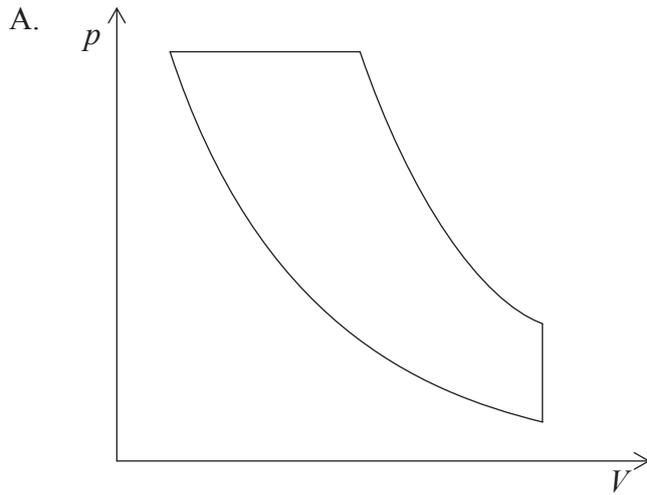
21. Boiling water in a beaker is heated continuously. Steam escapes into the surroundings.

Which of the following correctly lists the entropy changes of the boiling water and the surroundings?

	boiling water	surroundings
A.	increases	constant
B.	increases	increases
C.	decreases	constant
D.	decreases	increases

22. Plane parallel wavefronts are incident on an obstacle. Which of the following diagrams best shows the diffraction of the waves around the obstacle?

A.

B.

C.

D.
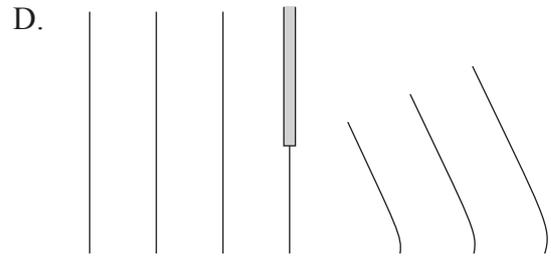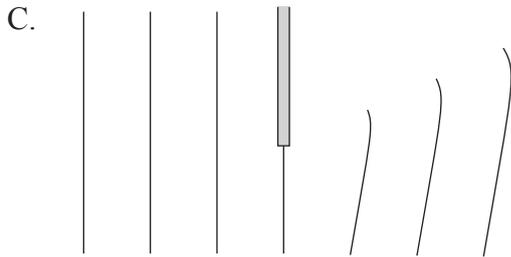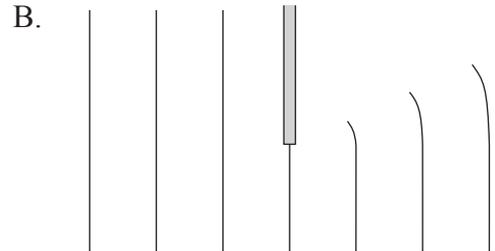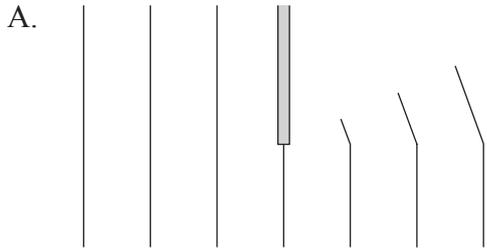
23. A vibrating tuning fork is held above the top of a tube that is filled with water. The water gradually runs out of the tube until a maximum loudness of sound is heard.

Which of the following best shows the standing wave pattern set up in the tube at this position?

A.   B.   C.   D.
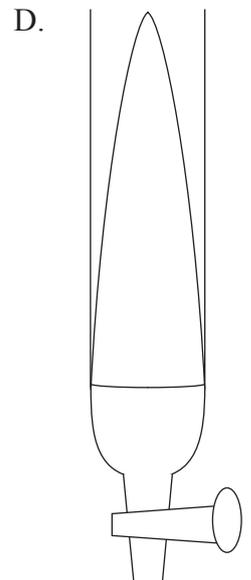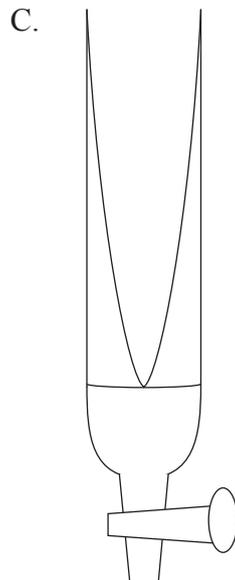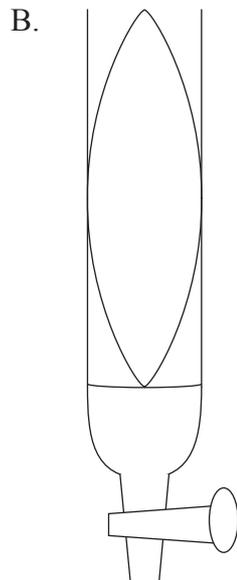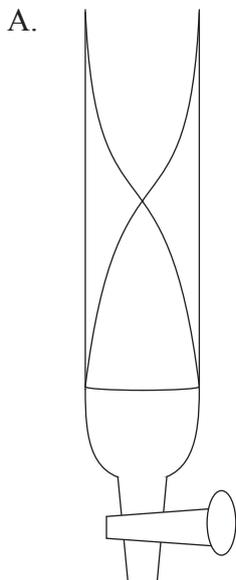
24. Which of the following is a correct description of the Doppler effect?

    A.   Change in frequency of light due to motion of the source of light.

    B.   Change in frequency of light due to relative motion between the source of light and the observer.

    C.   Change in observed frequency of light due to relative motion between the source of light and the observer.

    D.   Change in observed frequency of light due to change in velocity of the source of light.

25. In a double-slit experiment using coherent light of wavelength λ, the central bright fringe is observed on a screen at point O, as shown below.


coherent light

wavelength λ

double slit

P

O

screen

(not to scale)
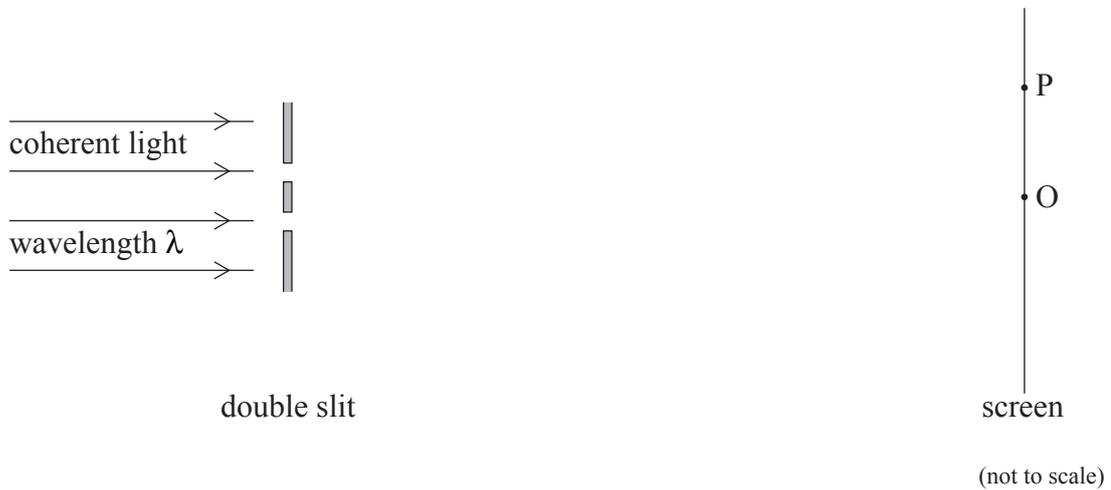
At point P, the path difference between light arriving at P from the two slits is 4λ.

Which of the following correctly describes the observed fringe pattern?

	nature of fringe at P	number of dark fringes between O and P
A.	bright	3
B.	bright	4
C.	dark	3
D.	dark	4

Turn over

26. Two pairs of uncharged parallel plates are placed in a vacuum and are connected as shown.
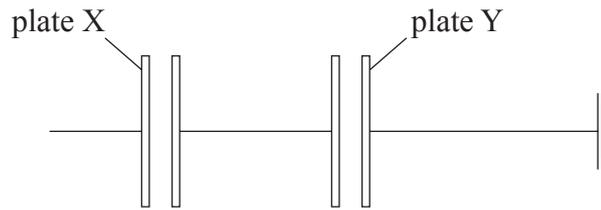
plate X   plate Y

A negative charge of magnitude q is placed on plate X. Plate Y is connected to earth. Which of the following diagrams shows the distribution of charge on the plates?

A.   X   Y

$-q$ $+q$

B.   X   Y

$-q$ $+q$

C.   X   Y

$-q$ $+q$ $-q$

D.   X   Y

$-q$ $+q$ $-q$ $+q$
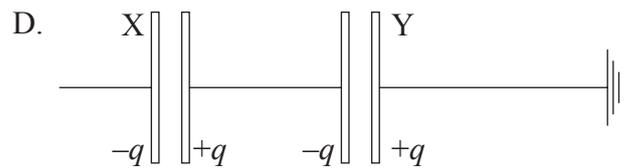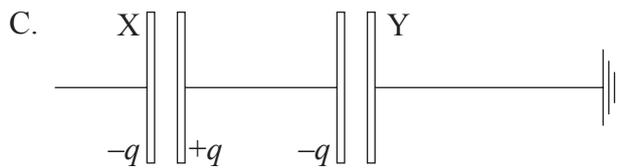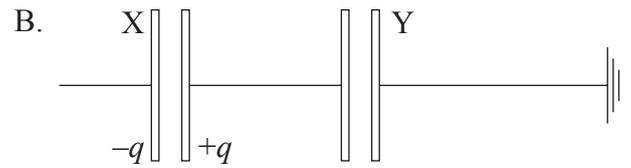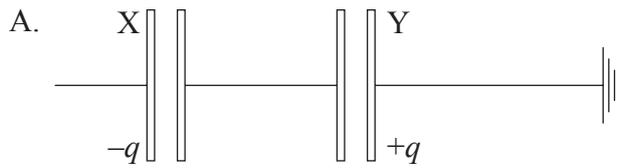
27. In the circuit below, resistors X, Y and Z are connected in series with a 9.0 V supply.
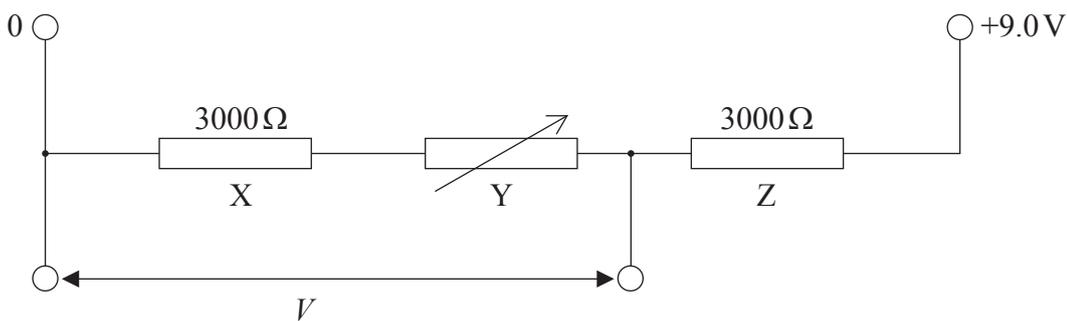

Resistors X and Z are fixed resistors of resistance 3000 Ω. The resistance of resistor Y may be varied between zero and 3000 Ω.

Which of the following gives the maximum range of potential difference V across the resistors X and Y?

A.   0 to 6.0 V

B.   3.0 V to 6.0 V

C.   4.5 V to 6.0 V

D.   4.5 V to 9.0 V

28. The Earth's magnetic field may be compared with that of a bar magnet.

Which of the following diagrams correctly shows the orientation of the bar magnet in this model?

A.   geographical north pole
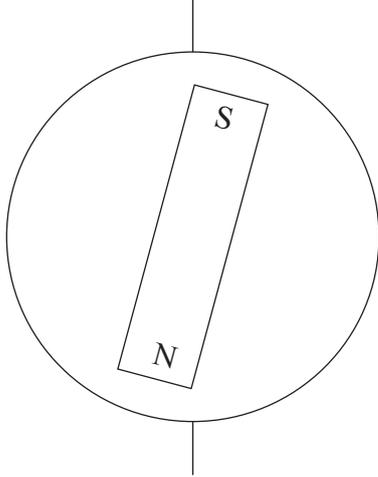
B.   geographical north pole
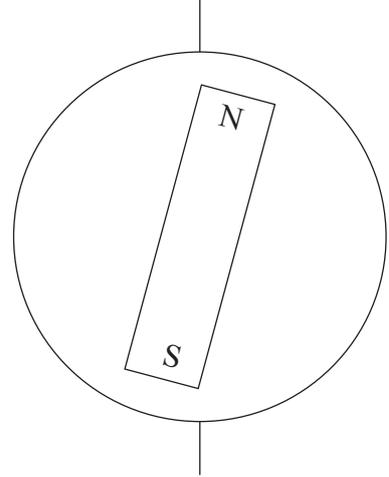
C.   geographical north pole
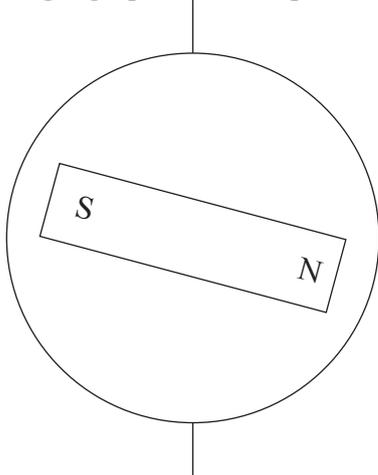
D.   geographical north pole
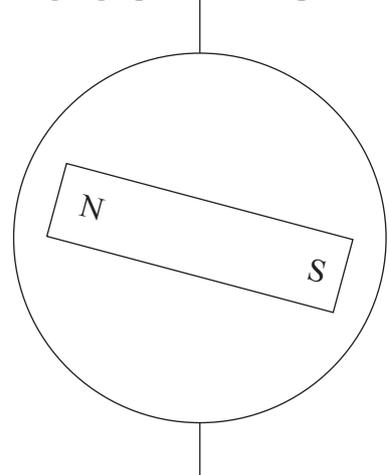
29. A direct current (dc) motor is connected to a battery by means of two leads. What is the function of the commutator of the motor?

A.   To allow the motor to produce a uniform turning effect.

B.   To prevent too large a current in the coil of the motor.

C.   To reverse the direction of current in the leads to the motor.

D.   To reverse the direction of current in the coil of the motor.

**30.** The diagram below shows some lines of equipotential in the region of an electric field.
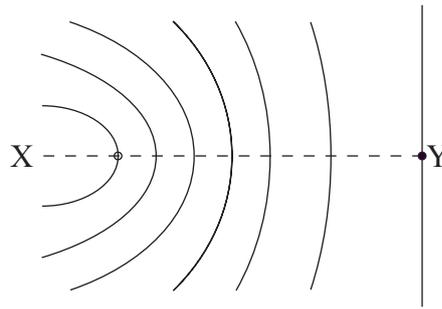
Which graph best shows the magnitude E of the electric field strength along the line XY?

A.

B.

C.

D.
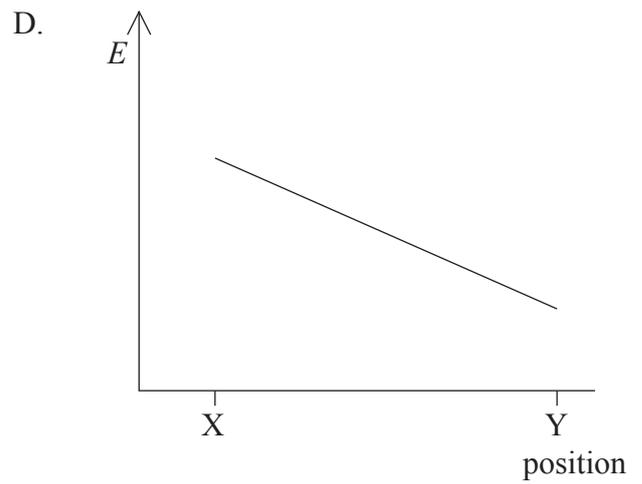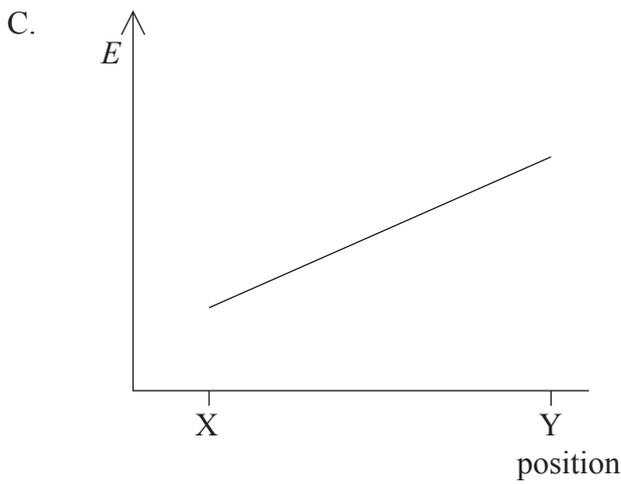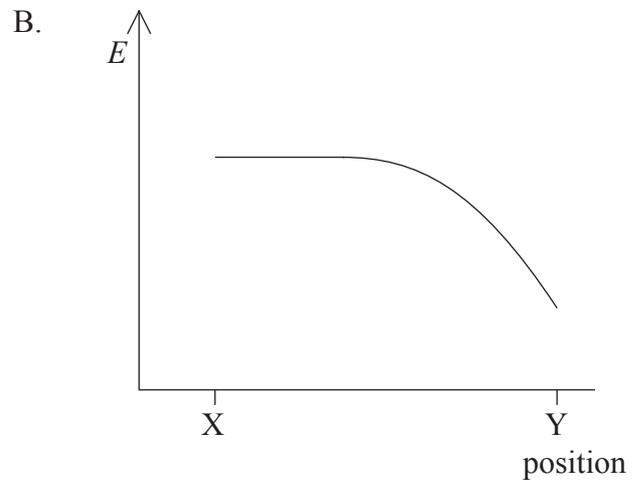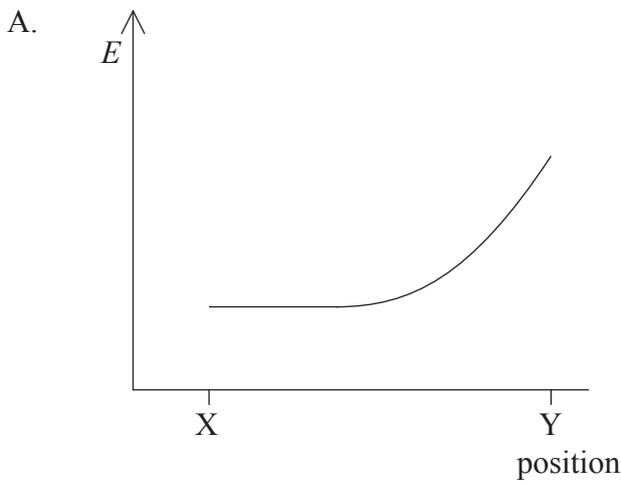
**31.** Two coils P and Q are arranged as shown below.
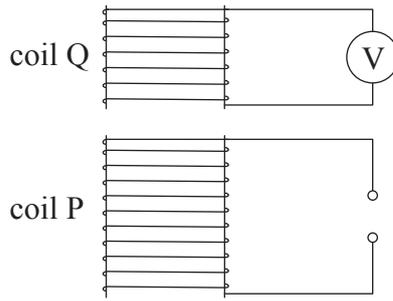
Coil Q is connected to a sensitive voltmeter. The current I in coil P is varied as shown below.
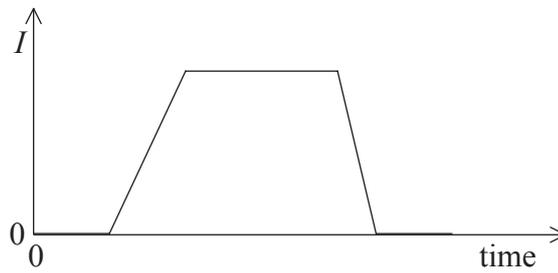
Which of the following graphs best shows the variation with time of the e.m.f. E induced in coil Q?

A.

B.

C.

D.
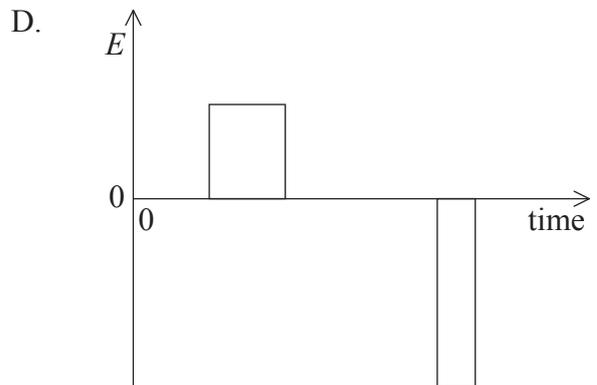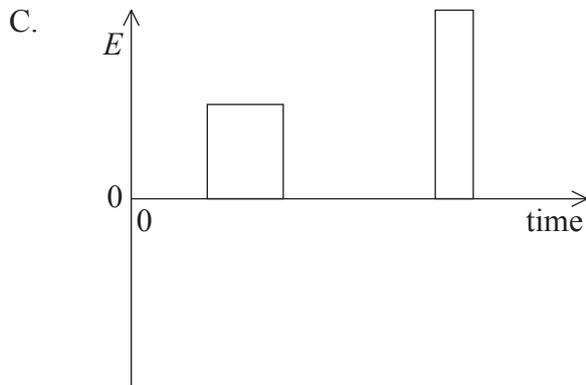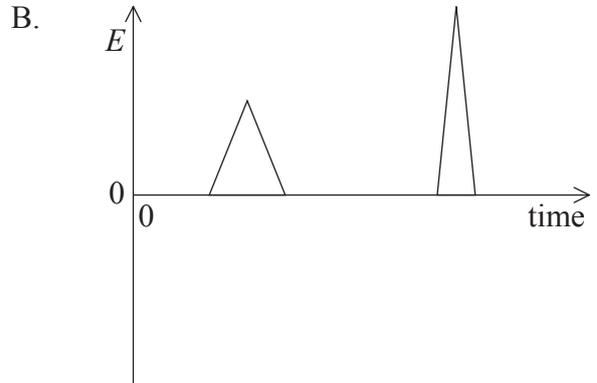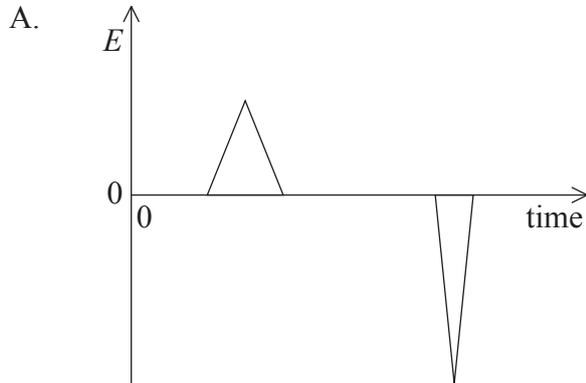
32. The graph below shows the variation with time t of the current I in a resistor.
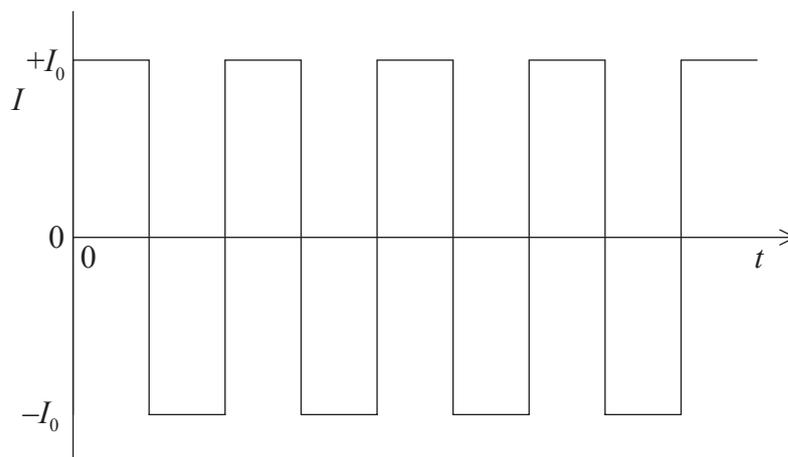
Which of the following is the root-mean-square value of the current I?

A. $\sqrt{2}I_0$

B. I_0

C. $\sqrt{I_0}$

D. $\dfrac{I_0}{\sqrt{2}}$

33. Which of the following statements best describes the **random** nature of radioactive decay?

A.   The decaying nucleus emits either an α-particle , or a β-particle or a γ-ray photon.

B.   The type of radiation emitted by the decaying nucleus cannot be predicted.

C.   The time at which a particular nucleus will decay cannot be predicted.

D.   The decay of a nucleus is unaffected by environmental conditions.

Turn over

34. The rest-mass of a nucleus of lithium-7 $\left(^{7}_{3}\text{Li}\right)$ is m_L. The rest-mass of a proton is m_P and the rest-mass of a neutron is m_N. The speed of light in free space is c.

Which of the following is a correct expression for the binding energy of a lithium-7 nucleus?

A. $(3m_P + 4m_N - m_L) c^2$

B. $(3m_P + 4m_N + m_L) c^2$

C. $(4m_P + 3m_N - m_L) c^2$

D. $(3m_P + 7m_N - m_L) c^2$

35. Light is incident on two different metal surfaces L and H. The metals are in a vacuum. The surface L has a lower work function energy than surface H.

Which of the following graphs best shows the variation with frequency f of the maximum kinetic energy E_{MAX} of photo-electrons emitted from both surfaces.

A.

B.

C.

D.
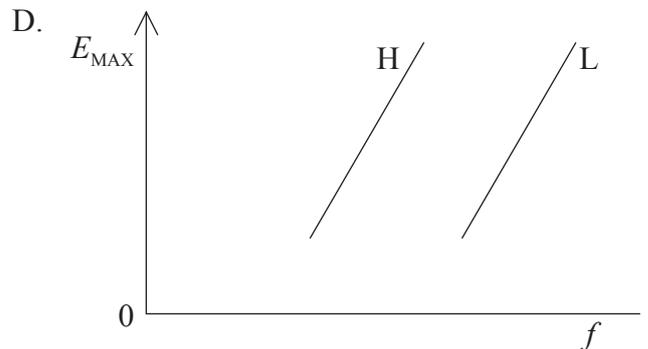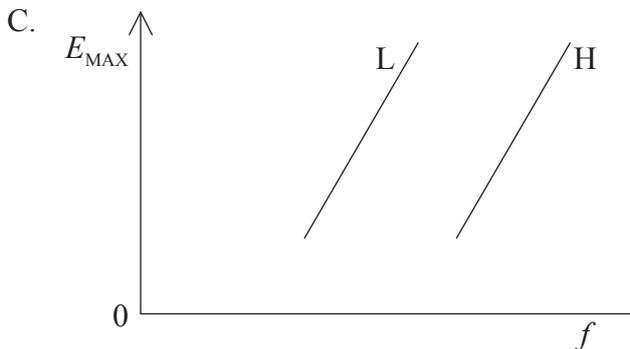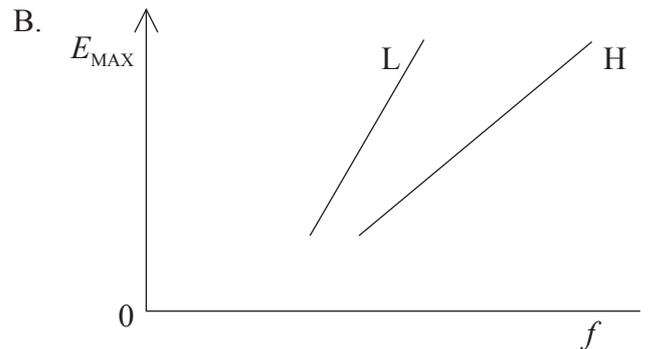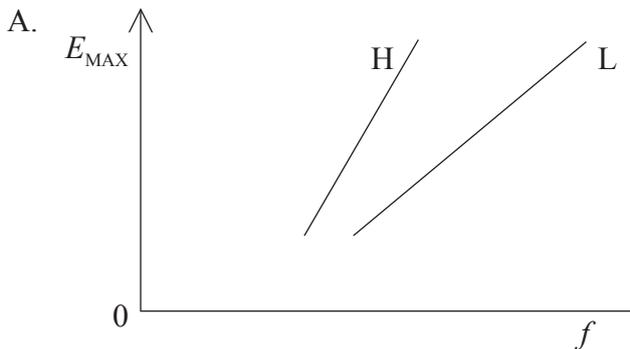
36. When X-rays are produced in an X-ray tube, the metal anode is either cooled or is made to spin rapidly.

Which of the following is the correct reason for this procedure?

A.   It reduces the intensity of the line spectrum of the metal target.

B.   More of the energy of the bombarding electrons is transferred to X-ray photon energy.

C.   Most of the energy of the bombarding electrons is transferred to thermal energy.

D.   It gives rise to a continuous distribution of X-ray wavelengths.

37. The masses of nuclei in a sample of uranium are determined using a mass spectrometer. Measurements suggest that some nuclei in the sample have double the mass of others.

Which of the following is the most likely explanation for this observation?

A.   Uranium nuclei are decaying radioactively.

B.   Several uranium isotopes are present.

C.   The uranium ions have different speeds.

D.   The uranium ions have different charges.

38. The probability of decay in one second of a radioactive nucleus is λ. During a particular one-second interval, a nucleus does not decay.

What is the probability of decay of this nucleus during the next one-second interval?

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

B. λ

C. 2λ

D. λ^2

39. The decay constant λ of a nuclide with a long half-life may be determined using the equation

$$\text{activity} = \lambda \times \text{number of nuclei present.}$$

Which of the following is the best explanation as to why this equation may be used?

A.   The decay constant λ is very large.

B.   The number of nuclei in a sample decreases rapidly.

C.   The activity of the sample decreases slowly.

D.   The sample contains a large number of nuclei.

40. Which of the following correctly lists the three classes of observed particles?

A.	leptons	hadrons	exchange bosons
B.	leptons	hadrons	quarks
C.	mesons	baryons	quarks
D.	mesons	baryons	exchange bosons