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

PHYSICS
HIGHER LEVEL
PAPER 1

Tuesday 11 November 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. The ratio $\dfrac{\text{diameter of a nucleus}}{\text{diameter of an atom}}$ is approximately equal to

    A. 10^{-15}.

    B. 10^{-8}.

    C. 10^{-5}.

    D. 10^{-2}.

2. A student measures a distance several times. The readings lie between 49.8 cm and 50.2 cm. This measurement is best recorded as

    A. 49.8 ± 0.2 cm.

    B. 49.8 ± 0.4 cm.

    C. 50.0 ± 0.2 cm.

    D. 50.0 ± 0.4 cm.

3. A measurement is made many times with four different instruments. For each instrument, a graph is plotted of the variation with reading r of the number n of times that reading was obtained. The true reading is R.

Which **one** of the following instruments provides readings that are the most precise **but** the least accurate?

A.   Instrument 1
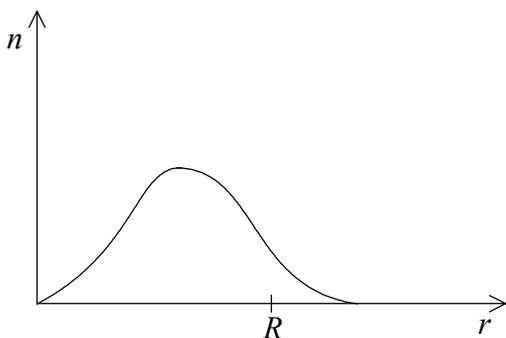
B.   Instrument 2
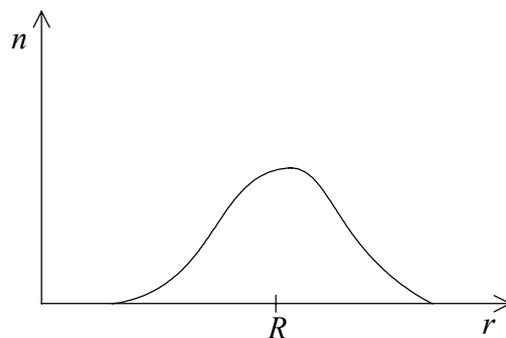
C.   Instrument 3
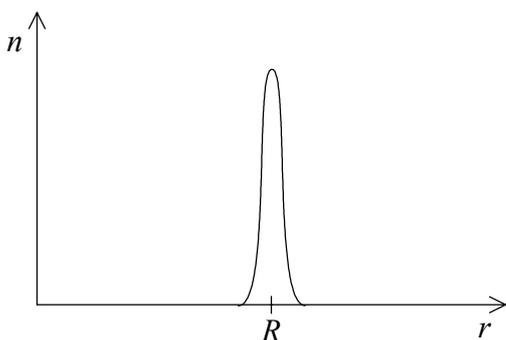
D.   Instrument 4
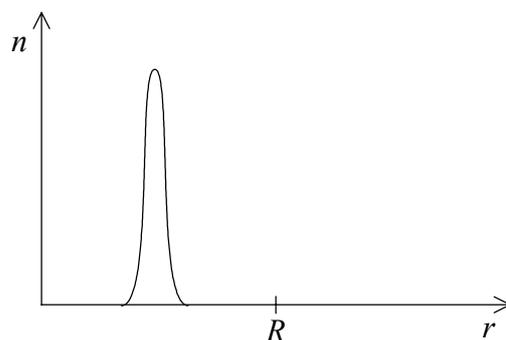
4. Two forces of magnitudes 7 N and 5 N act at a point. Which **one** of the following is **not** a possible value for the magnitude of the resultant force?

A.   1 N

B.   3 N

C.   5 N

D.   7 N

Turn over

5.   An object on the end of a light flexible string rotates in a circle as shown below.
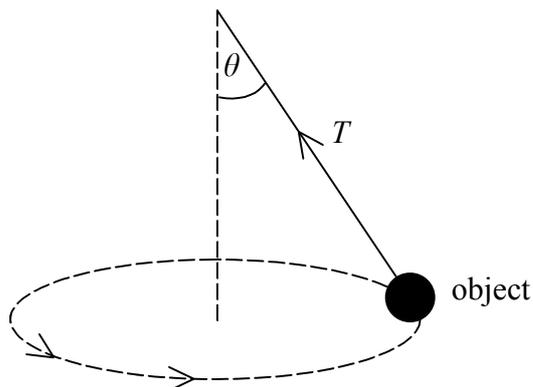
The tension in the string is T when the string is at angle θ to the vertical. Which of the following is true?

	State	Resultant force
A.	not in equilibrium	T
B.	not in equilibrium	$T \sin\theta$
C.	in equilibrium	T
D.	in equilibrium	$T \sin\theta$

6. A car is heading due East at a speed of $10\,\text{m\,s}^{-1}$. A bird is flying due North at a speed of $4\,\text{m\,s}^{-1}$, as shown below.

Car

$4\,\text{m\,s}^{-1}$

N

W —|— E

S

$10\,\text{m\,s}^{-1}$ Bird
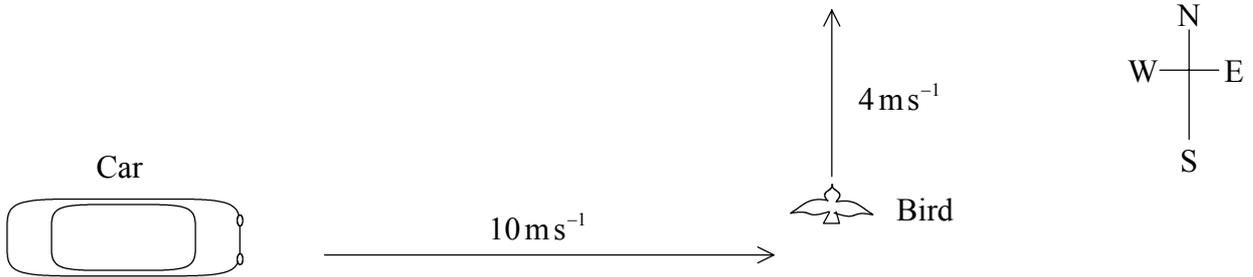
Which **one** of the following vectors represents the velocity of the bird relative to a person in the car?

A.
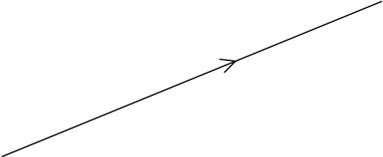
B.
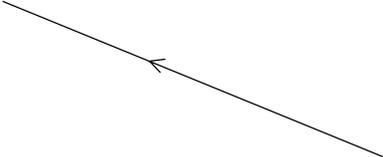
C.
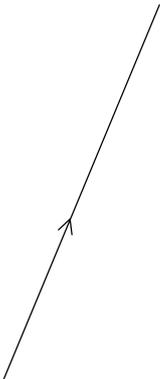
D.
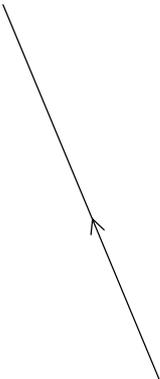
7. A ball is released from rest near the surface of the Moon. Which **one** of the following quantities increases at a constant rate?

A.   Only distance fallen

B.   Only speed

C.   Only speed and distance fallen

D.   Only speed and acceleration

Turn over

8. A stone is thrown from O at an angle to the horizontal. Which sketch below best shows the path of the stone when air resistance is **not** neglected? On each sketch, the broken line shows the path for the same stone in a vacuum.

A.

O

B.

O

C.

O

D.

O
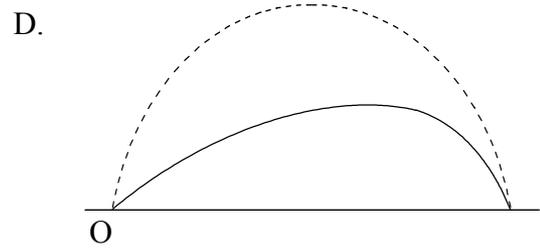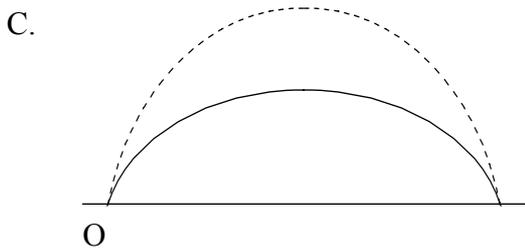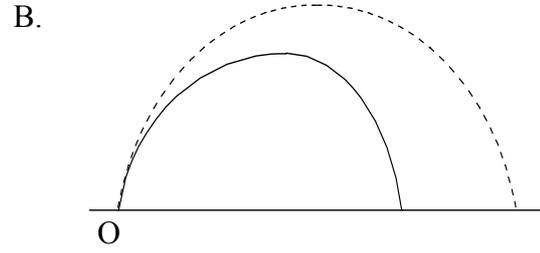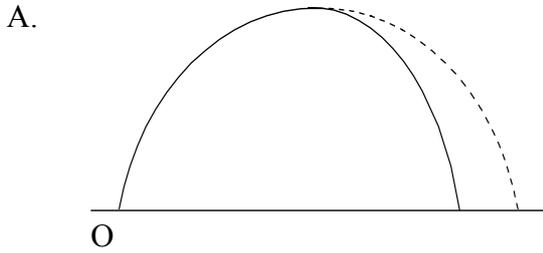
9. An object is moving at constant velocity. Which **one** of the following quantities **must** have zero magnitude?

    A.   Weight of object

    B.   Momentum of object

    C.   Kinetic energy of object

    D.   Resultant force on object

10. A ball of mass m falls from rest on to a horizontal plate and bounces off it. The magnitudes of its velocity just before and just after the bounce are v_1 and v_2 respectively. The variation with time t of the velocity v of the ball is shown below.
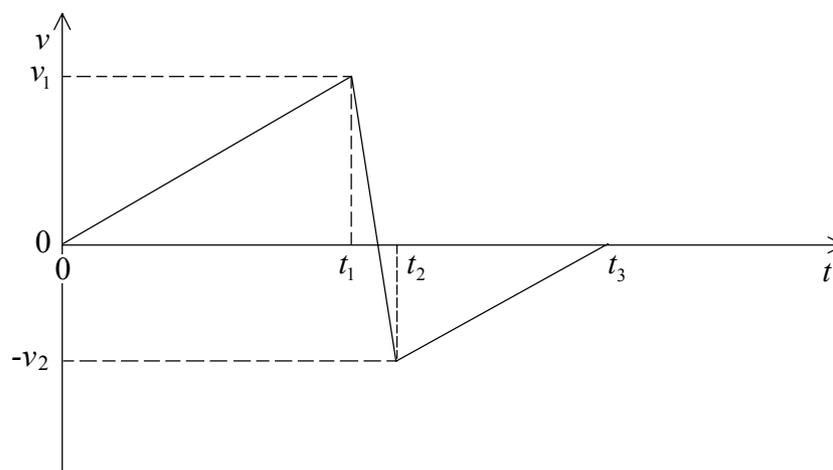
The magnitude of the net force on the ball is given by which **one** of the following?

A. $\dfrac{mv_1}{t_1}$

B. $\dfrac{mv_2}{(t_3 - t_2)}$

C. $\dfrac{m(v_1 - v_2)}{(t_2 - t_1)}$

D. $\dfrac{m(v_1 + v_2)}{(t_2 - t_1)}$

11. Gravitational field strength at a point may be defined as

A. the force on a small mass placed at the point.

B. the force per unit mass on a small mass placed at the point.

C. the work done to move unit mass from infinity to the point.

D. the work done per unit mass to move a small mass from infinity to the point.

12. A block is placed on a horizontal rough surface. A horizontal force F is applied to the block, as shown below.
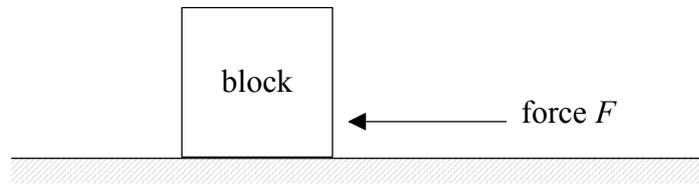
block

force F

The force required to keep the block moving at constant speed is less than the force required to make the block move from rest. The **explanation** for this observation is that

A.   before the block moves, the force F must also produce a turning moment.

B.   a force is not required to keep the block moving at constant speed.

C.   friction has to be overcome to make the block move.

D.   the maximum static friction forces are greater than the maximum dynamic friction forces.

13. The diagram below shows a shape cut from a thin sheet of metal of constant thickness. Which point best shows the position of the centre of gravity of the shape?

A

B

C

D
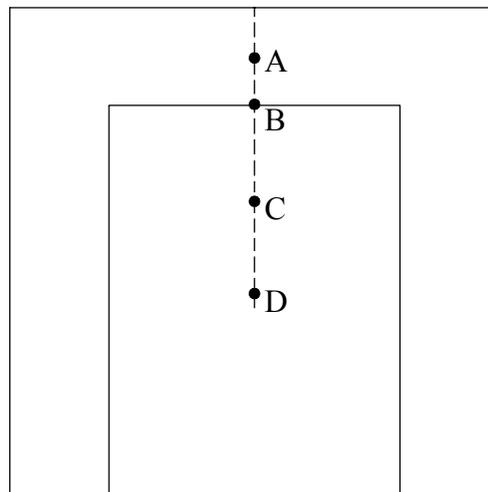
14. The diagram below shows the variation with displacement x of the force F acting on an object in the direction of the displacement.
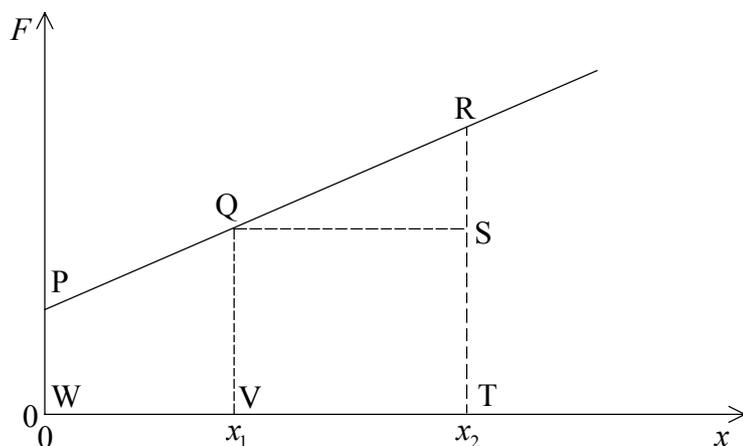
Which area represents the work done by the force when the displacement changes from x_1 to x_2?

A. QRS

B. WPRT

C. WPQV

D. VQRT

15. Which two values of temperature are equivalent to the nearest degree when measured on the Kelvin and on the Celsius scales of temperature?

	Kelvin scale	Celsius scale
A.	40	313
B.	273	100
C.	313	40
D.	373	0

Turn over

16. An engine takes in an amount E of thermal energy and, as a result, does an amount W of useful work. An amount H of thermal energy is ejected. The law of conservation of energy and the efficiency of the engine are given by which of the following?

	Law of conservation of energy	Efficiency
A.	$E = W + H$	W
B.	$E = W + H$	$\dfrac{W}{E}$
C.	$E + H = W$	$\dfrac{W}{H}$
D.	$E + H = W$	$\dfrac{W}{(E-H)}$

17. Two different objects are in thermal contact with one another. The objects are at different temperatures. The temperatures of the two objects determine

A. the process by which thermal energy is transferred.

B. the heat capacity of each object.

C. the direction of transfer of thermal energy between the objects.

D. the amount of internal energy in each object.

18. A sample of an ideal gas is held in an insulated container and it undergoes an adiabatic change. The graph below shows the change in pressure p with change in volume V as the gas changes from X to Y.
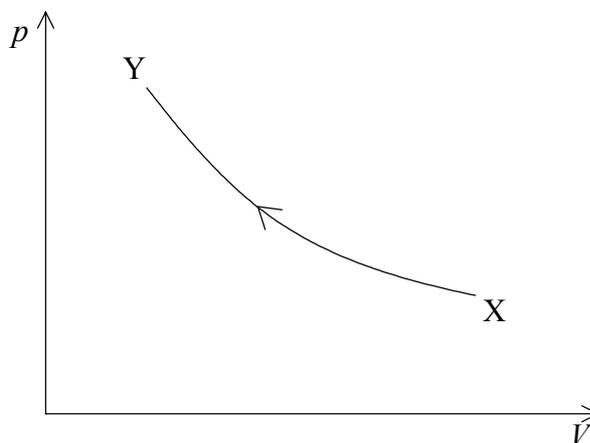
Which of the following describes correctly the work done and the change in the internal energy of the gas?

	Work done	Internal energy
A.	on the gas	increases
B.	on the gas	decreases
C.	by the gas	decreases
D.	by the gas	increases

19. A substance changes from solid to liquid at its normal melting temperature. What change, if any, occurs in the average kinetic energy and the average potential energy of its molecules?

	Average kinetic energy	Average potential energy
A.	constant	constant
B.	increases	constant
C.	increases	decreases
D.	constant	increases

Turn over

20. The specific latent heat of vaporization of a substance is greater than its specific latent heat of fusion because

  A.   boiling takes place at a higher temperature than melting.

  B.   thermal energy is required to raise the temperature from the melting point to the boiling point.

  C.   the volume of the substance decreases on freezing but increases when boiling.

  D.   the increase in potential energy of the molecules is greater on boiling than on melting.

21. A container holds 20 g of neon (mass number 20) and also 8 g of helium (mass number 4).

What is the ratio $\dfrac{\text{number of atoms of neon}}{\text{number of atoms of helium}}$?

  A.   0.4

  B.   0.5

  C.   2.0

  D.   2.5

22. The speed of a wave is defined as

  A.   the speed at which the particles of the wave vibrate.

  B.   the speed of the medium through which the wave passes.

  C.   the speed of transfer of the energy of the wave.

  D.   the speed at which the vibrations of the wave are produced.

23. Which diagram best shows diffraction of plane wavefronts at a single slit?

A.

B.

C.

D.
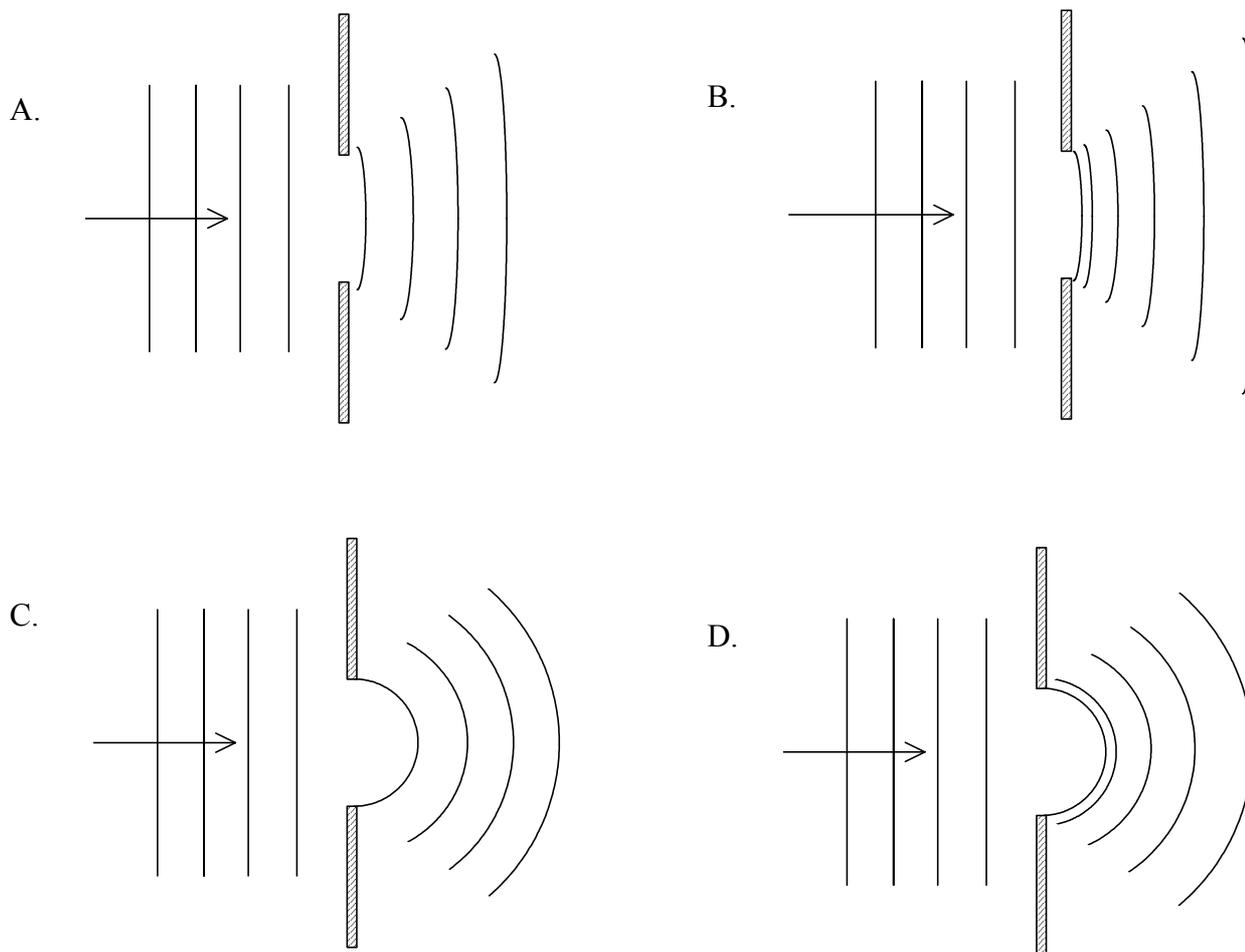
24. A source of sound moves directly towards a stationary observer. The frequency of the sound detected by the observer is different from the source frequency because

A.   the loudness of the sound increases as the source moves towards the observer.

B.   the apparent wavelength of the sound is longer.

C.   the speed of sound relative to the observer is increased.

D.   the apparent wavelength of the sound is shorter.

25. Monochromatic light passes through two slits s_1 and s_2 and produces light and dark fringes on a screen. Initially, the light from the two slits is of equal intensity.
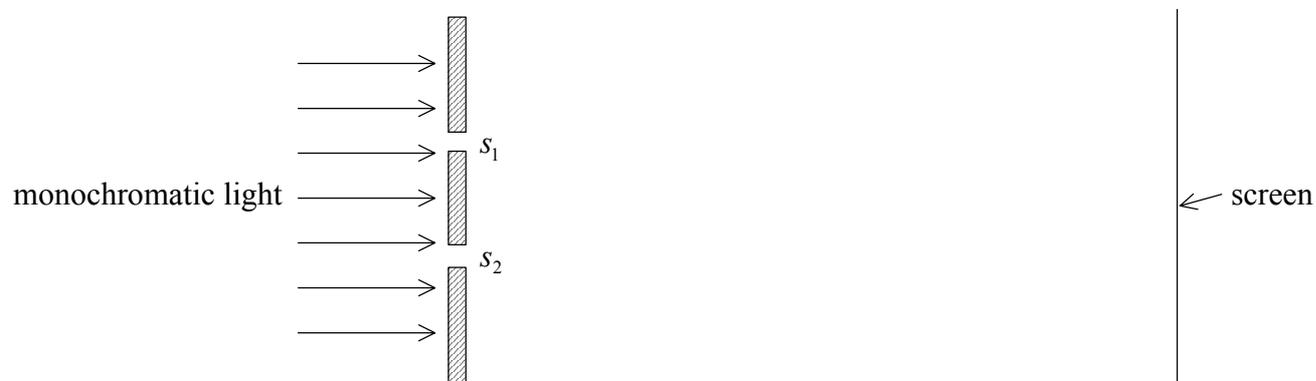
The light from one slit now has its intensity reduced. The intensity at the other is unchanged. What changes (if any) will occur in the appearance of the fringes on the screen?

	Fringe separation	**Dark fringes**
A.	same	lighter
B.	same	same
C.	increased	same
D.	decreased	lighter

26. Two particles X and Y are situated a distance $\frac{1}{2}\lambda$ apart on a stationary wave of wavelength λ. The variation with time t of the displacement d_X of X is shown below.
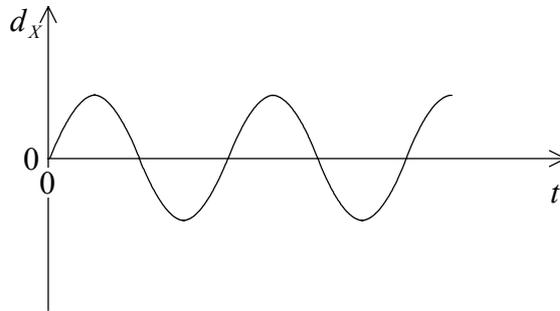
Which **one** of the following correctly shows the variation with time t of the displacement d_Y of particle Y?

A.

B.

C.

D.
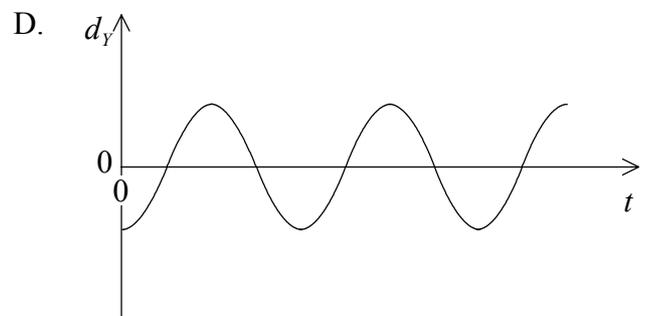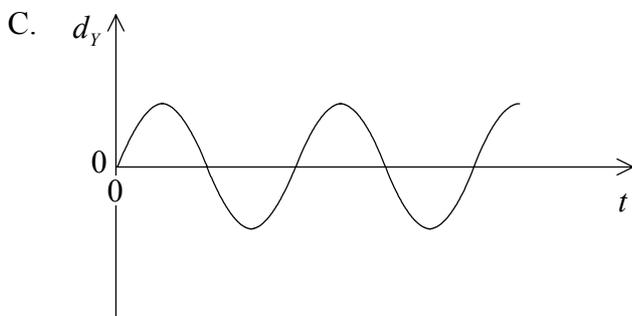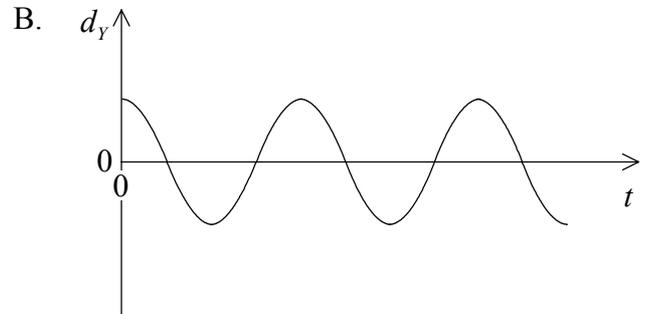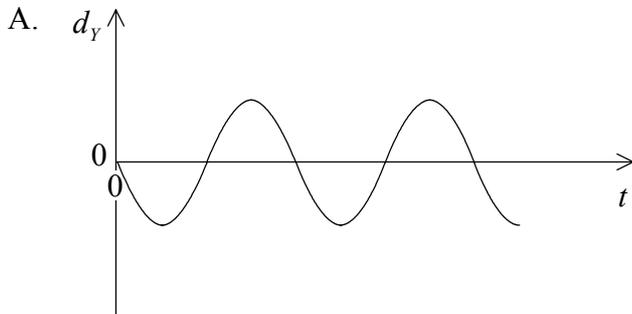
27. A plastic rod is rubbed with a cloth. At the end of the process, the rod is found to be positively charged and the cloth is found to be uncharged. This involves the movement of

A.   positive charge from the cloth to the rod.

B.   positive charge from earth to the cloth.

C.   negative charge from the rod to earth.

D.   negative charge from earth to the cloth.

28. The diagram below shows lines of electric equipotential. The change in potential on moving from one line to the next is always the same. At which point does the electric field strength have its greatest magnitude?

A
•

•
B

•
C

•
D
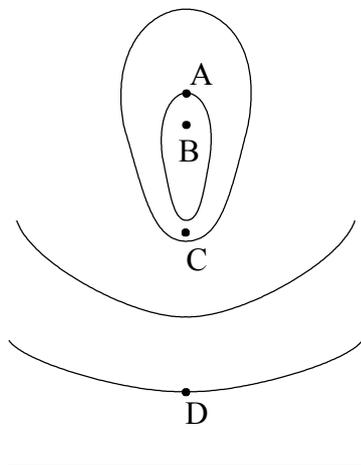
29. The variation with potential difference V of the current I in an electric lamp is shown below.
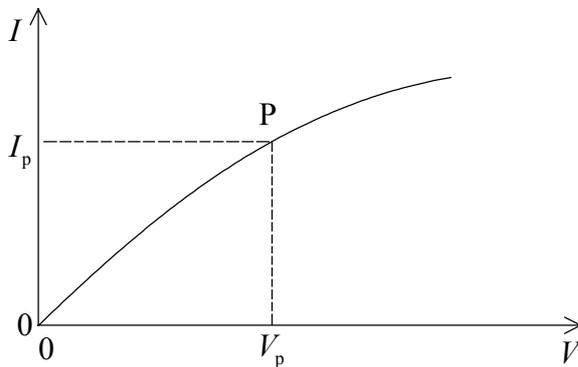
At point P, the current is I_p, the potential difference is V_p and the gradient of the tangent to the curve is G. What is the resistance of the lamp at point P?

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

B. G

C. $\dfrac{I_p}{V_p}$

D. $\dfrac{V_p}{I_p}$

883-170

30. A cell of e.m.f. *E* and internal resistance *r* is connected to a variable resistor. A voltmeter is connected so as to measure the potential difference across the terminals of the cell. Which **one** of the following is the correct circuit diagram of the arrangement?

A.

B.

C.

D.

　　　　　　　　　　　　　　　　　　　　　　　　　　　Turn over
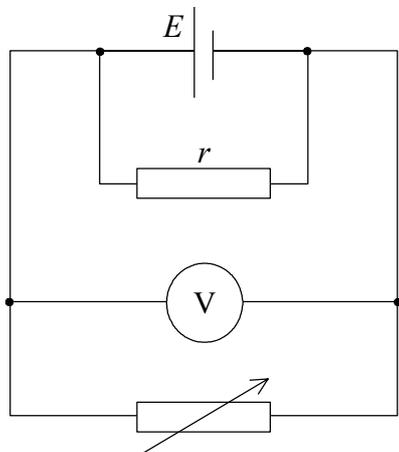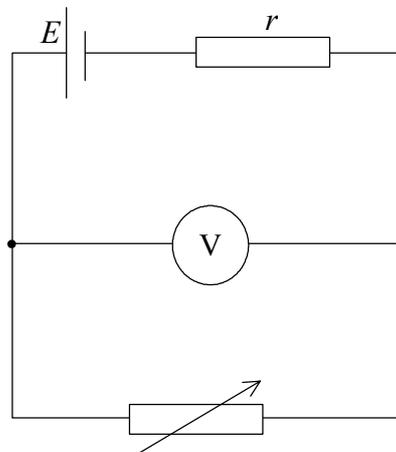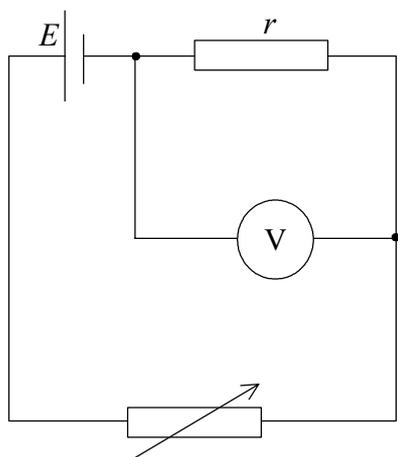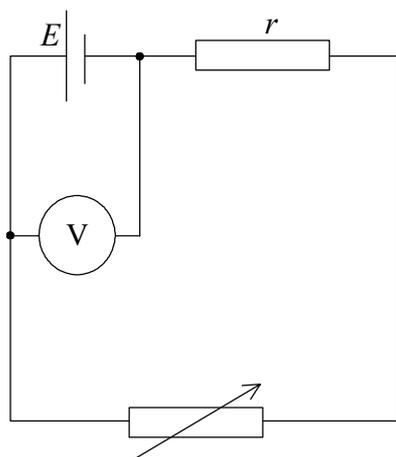
31. A strip of aluminium foil is held between the poles of a strong magnet, as shown below.
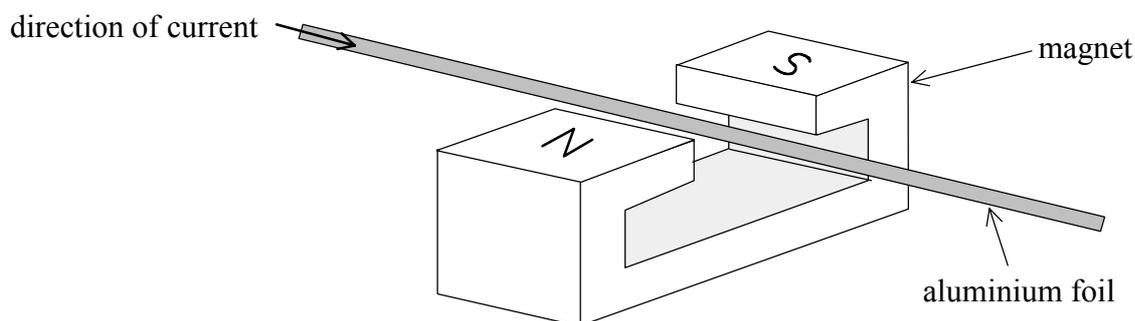
When a current is passed through the aluminium foil in the direction shown, the foil is deflected. In which direction is this deflection?

A.   Vertically downwards

B.   Vertically upwards

C.   Towards the North pole of the magnet

D.   Towards the South pole of the magnet

32. The diagram below shows the variation with time t of the e.m.f. E generated in a coil rotating in a uniform magnetic field.
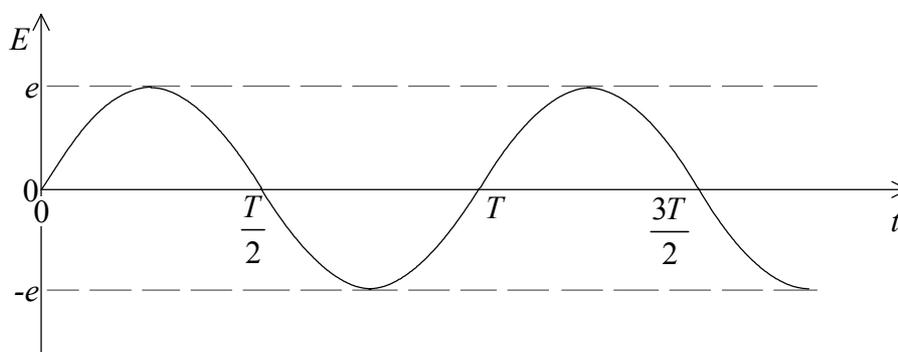
What is the root-mean-square value E_{rms} of the e.m.f. and also the frequency f of rotation of the coil?

	E_{rms}	f
A.	e	$\dfrac{2}{T}$
B.	e	$\dfrac{1}{T}$
C.	$\dfrac{e}{\sqrt{2}}$	$\dfrac{2}{T}$
D.	$\dfrac{e}{\sqrt{2}}$	$\dfrac{1}{T}$

33. Which **one** of the following provides direct evidence for the existence of discrete energy levels in an atom?

   A. The continuous spectrum of the light emitted by a white-hot metal.

   B. The line emission spectrum of a gas at low pressure.

   C. The emission of gamma radiation from radioactive atoms.

   D. The ionization of gas atoms when bombarded by alpha particles.

34. The work function of a metal may be defined as

   A. the minimum frequency of the incident electromagnetic radiation required to cause photoelectric emission.

   B. the minimum wavelength of the incident electromagnetic radiation required to cause photoelectric emission.

   C. the minimum energy of photons incident on a surface required to cause photoelectric emission.

   D. the minimum energy required to take an electron from the interior to the surface to cause photoelectric emission.

35. The graph below shows a typical X-ray spectrum produced when electrons are accelerated through a potential difference and are then stopped in a metal target.
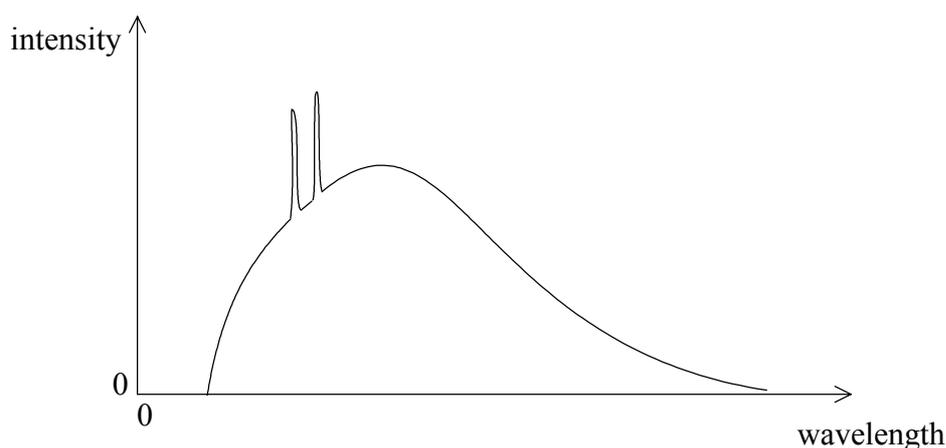
Which feature of the graph enables this potential difference to be determined?

   A. The maximum wavelength of the X-rays produced

   B. The minimum wavelength of the X-rays produced

   C. The wavelength of the peaks on the graph

   D. The maximum intensity of the X-rays produced

Turn over

36. The variation with thickness x of the number n of α-particles penetrating a material is shown below.
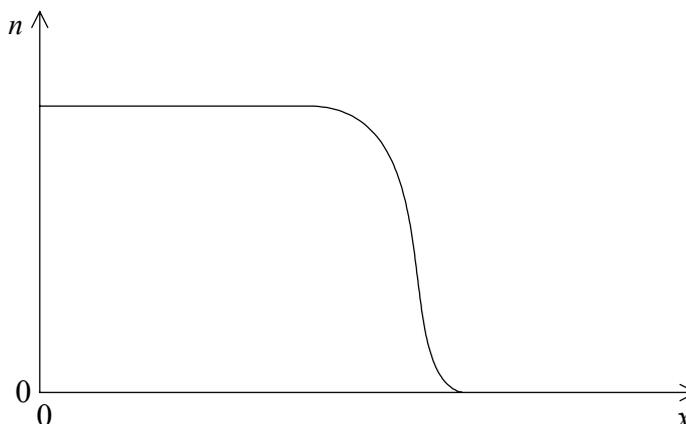
What can be deduced from the graph about the α-particles ?

A.   The α-particles have approximately the same initial energy.

B.   The range is independent of the initial energy.

C.   The α-particles produce high levels of ionization.

D.   The α-particles have a large mass.

37. A sample of material initially contains atoms of only one radioactive isotope. Which **one** of the following quantities is reduced to one half of its initial value during a time equal to the half-life of the radioactive isotope?

A.   Total mass of the sample

B.   Total number of atoms in the sample

C.   Total number of nuclei in the sample

D.   Activity of the radioactive isotope in the sample

38. Which **one** of the following is a correct definition of the decay constant of a radio-isotope?

A.   The constant of proportionality linking half-life to rate of decay of nuclei.

B.   The constant of proportionality linking decay rate to number of undecayed nuclei.

C.   The reciprocal of the half-life of the radio-isotope.

D.   The rate of decay of nuclei in a fresh sample of the radio-isotope.

39. K-capture is a process that occurs when a nucleus captures an electron from the innermost shell of electrons surrounding the nucleus.

When K-capture occurs in iron-55 $(^{55}_{26}\text{Fe})$, the nucleus is changed into a manganese (Mn) nucleus. Which equation represents this change?

A. $(^{55}_{26}\text{Fe}) + {}^{0}_{1}\text{e} \rightarrow {}^{55}_{27}\text{Mn}$

B. $(^{55}_{26}\text{Fe}) + {}^{1}_{1}\text{e} \rightarrow {}^{56}_{27}\text{Mn}$

C. $(^{55}_{26}\text{Fe}) + {}^{0}_{-1}\text{e} \rightarrow {}^{55}_{25}\text{Mn}$

D. $(^{55}_{26}\text{Fe}) + {}^{1}_{-1}\text{e} \rightarrow {}^{56}_{25}\text{Mn}$

40. Which **one** of the following lists the three classes of fundamental particle?

A. leptons   quarks   exchange bosons

B. hadrons   quarks   exchange bosons

C. leptons   mesons   baryons

D. hadrons   baryons   mesons