International Baccalaureate®
Baccalauréat International
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PHYSICS
HIGHER LEVEL
PAPER 1

Wednesday 6 November 2013 (morning)

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.
- A clean copy of the **Physics** Data Booklet is required for this paper.
- The maximum mark for this examination paper is [40 marks].

1. The sides of a square are measured to be $5.0 \pm 0.2\,\text{cm}$. Which of the following gives the area of the square and its uncertainty?

    A. $25.0 \pm 0.2\,\text{cm}^2$

    B. $25.0 \pm 0.4\,\text{cm}^2$

    C. $25 \pm 2\,\text{cm}^2$

    D. $25 \pm 4\,\text{cm}^2$

2. Two identical balls are dropped at the same time. Ball A is dropped from a height h and ball B from a height $2h$. Air resistance is negligible.

What is the ratio $\dfrac{\text{time for B to hit the ground}}{\text{time for A to hit the ground}}$?

    A.   2

    B. $\sqrt{2}$

    C. $\dfrac{1}{\sqrt{2}}$

    D. $\dfrac{1}{2}$

3. A model plane flies with constant velocity at constant height. Which diagram represents the forces acting on the plane?

   A.

    B.

    C.

    D.
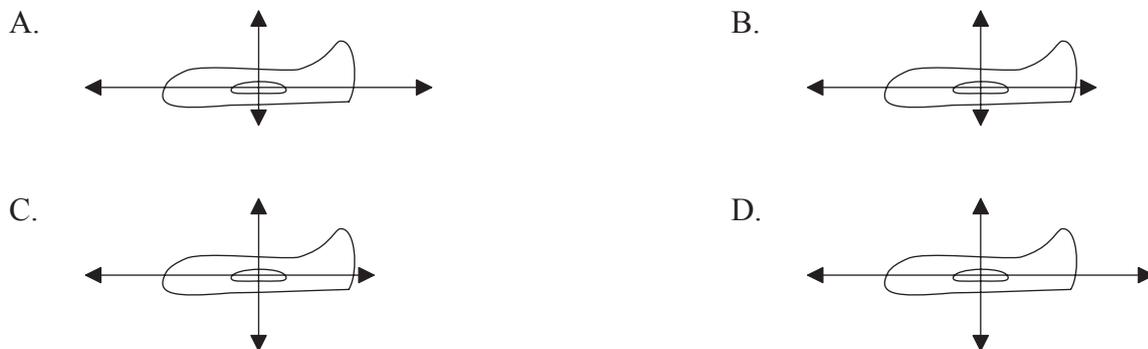
4.   A force which increases uniformly from 0 to a maximum value of F is applied to an object. The object does not move until the force exceeds $0.5F$. As the force increases from $0.5F$ to F the object moves a distance x in the direction of the force. What is the work done by this force?

   A. $0.25Fx$

   B. $0.5Fx$

   C. $0.75Fx$

   D. Fx

5.   A body moves with uniform speed around a circle of radius r. The period of the motion is T. What is the speed of the body?

   A. $\dfrac{2\pi r}{T}$

   B. $\dfrac{2\pi T}{r}$

   C.   Zero

   D. $\dfrac{\pi r^2}{T}$

6.   Which of the following is true about boiling and evaporation?

	Boiling	**Evaporation**
A.	occurs throughout liquid	occurs at liquid surface
B.	occurs throughout liquid	occurs throughout liquid
C.	occurs at liquid surface	occurs at liquid surface
D.	occurs at liquid surface	occurs throughout liquid

7. A solid of mass m is initially at temperature ΔT below its melting point. The solid has specific heat capacity c and specific latent heat of fusion L. How much thermal energy must be transferred to the solid in order to melt it completely?

A. $mL + mc$

B. $mc + mL\Delta T$

C. $mc\Delta T + L\Delta T$

D. $mc\Delta T + mL$

8. The graph shows the variation of pressure P with volume V of an ideal gas during a thermodynamic cycle.
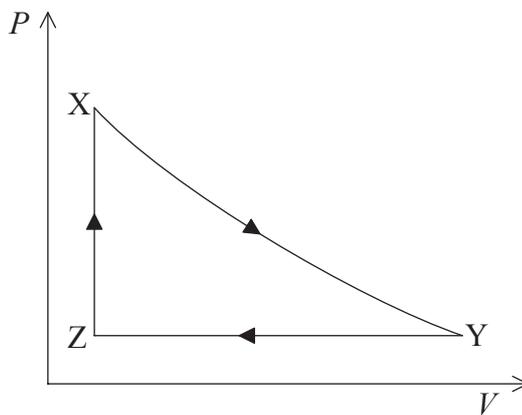
During which stages is work done on the gas and work done by the gas?

	Work done on gas	**Work done by gas**
A.	X→Y only	Y→Z only
B.	X→Y and Z→X	Y→Z only
C.	Y→Z only	Z→X and X→Y
D.	Y→Z only	X→Y only

9. A piece of ice melts at constant temperature. Which of the following gives the correct change in the entropy of the water molecules and that of the surroundings?

	entropy of water molecules	entropy of surroundings
A.	increases	decreases
B.	decreases	decreases
C.	increases	increases
D.	decreases	increases

**10.** For a body undergoing simple harmonic motion the velocity and acceleration are

A.   always in the same direction.

B.   always in opposite directions.

C.   in the same direction for a quarter of the period.

D.   in the same direction for half the period.

11. Which graph of displacement x against time t represents the motion of a critically damped body?

Turn over
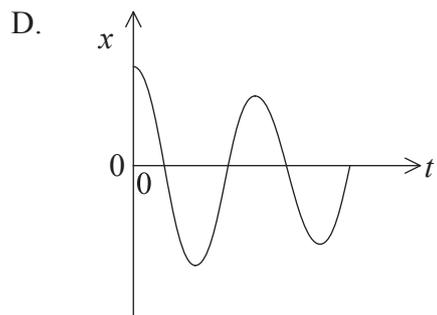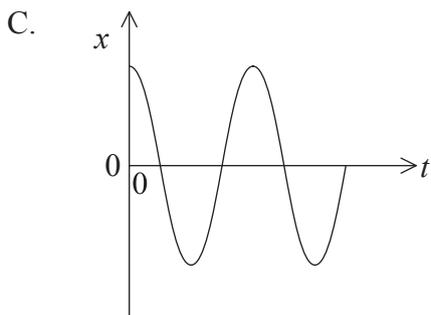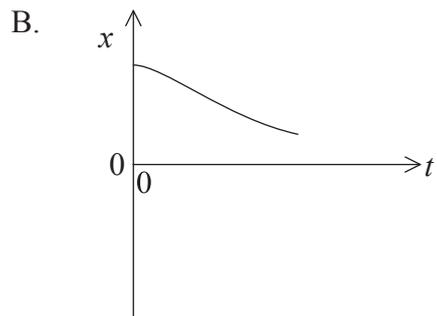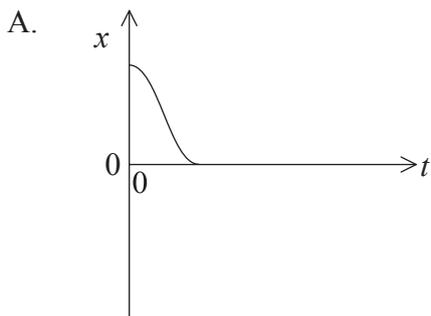
12. Which of the following relates the amplitude A of a travelling wave to the intensity I?

A. $A \propto I^{-1}$

B. $A \propto I^{-\frac{1}{2}}$

C. $A \propto I^{\frac{1}{2}}$

D. $A \propto I^{2}$

13. The diagrams show four different organ pipes drawn to scale. Standing waves in the fundamental (first harmonic) mode are set up inside each pipe. Which pipe produces a fundamental note with the lowest frequency?

A.

B.

C.

D.
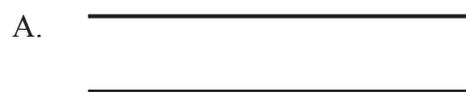
14. An ambulance emits a sound of frequency f as it travels along a straight road between stationary observers A and B.

direction of motion

ambulance

observer A   observer B
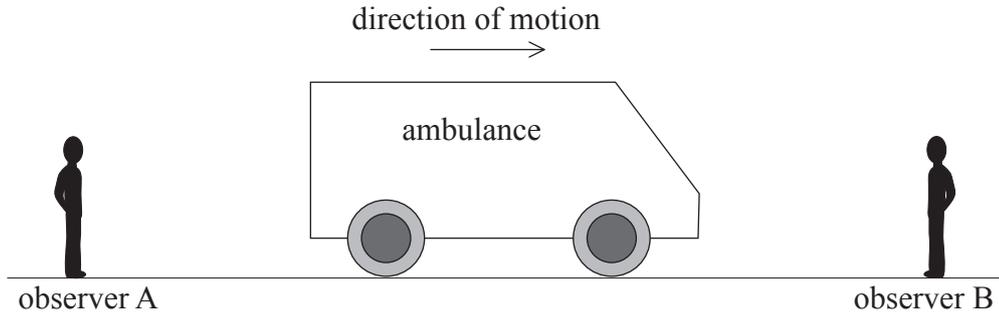
Which of the following shows how the frequency of the sound heard by each observer compares with f?

|	**Observer A**	**Observer B**
A.	greater than f	greater than f
B.	greater than f	less than f
C.	less than f	greater than f
D.	less than f	less than f

15. The intensity distribution of monochromatic light passing through a narrow slit and then incident on a screen is shown below.
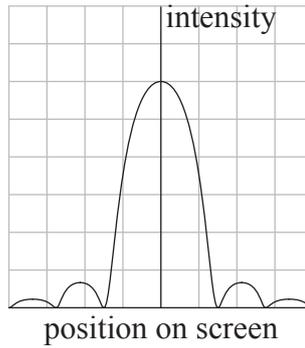
When the slit width is reduced which diagram shows the new intensity distribution? Diagrams are drawn to the same scale as the original.

A.

B.

C.

D.
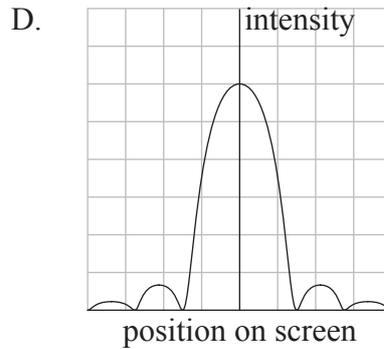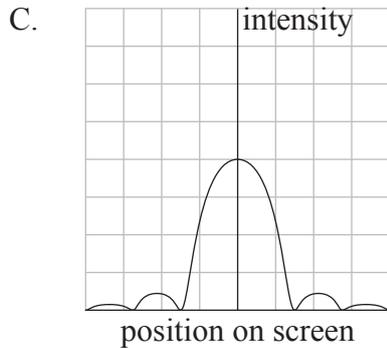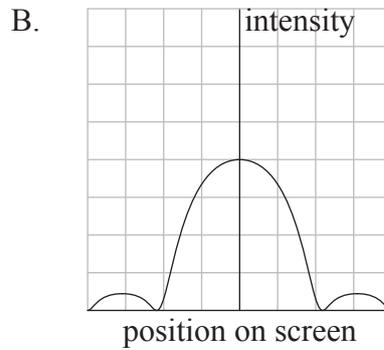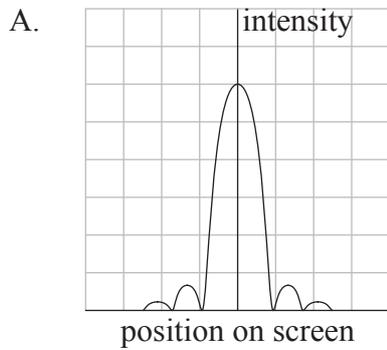
16. Two polarizing filters are set up so the transmitted light is at a maximum intensity.
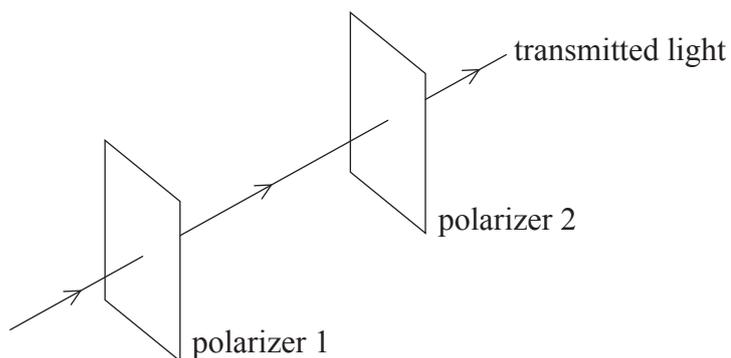
Through which angle should polarizer 2 be rotated so that no light is transmitted?

A. $45°$

B. $60°$

C. $90°$

D. $180°$

17. A resistor X of resistance R is made of wire of length L and cross-sectional area A. Resistor Y is made of the same material but has a length $4L$ and a cross-sectional area $2A$. X and Y are connected in series. What is the total resistance of the combination?

A. $1.5R$

B. $2R$

C. $3R$

D. $9R$

18. Each of the resistors in the circuit has a resistance of $2.0\,\Omega$. The cell has an emf of $3.0\,V$ and negligible internal resistance. The ammeter has negligible resistance.

3.0 V
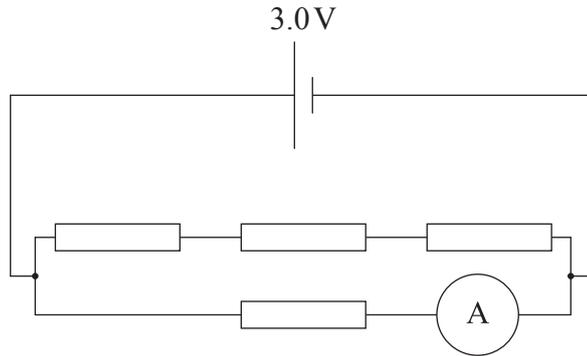
What is the ammeter reading?

A. $0.4\,A$

B. $0.5\,A$

C. $1.5\,A$

D. $2.0\,A$

19. Which diagram represents the pattern of electric field lines of two small positive point charges held at the positions shown?

A.

B.

C.

D.
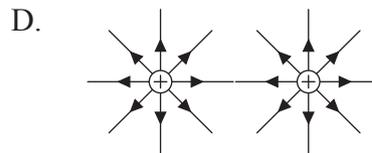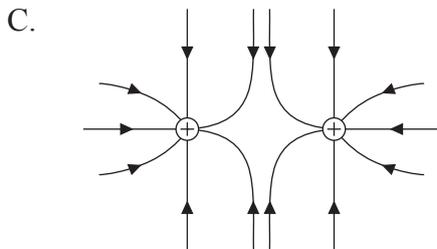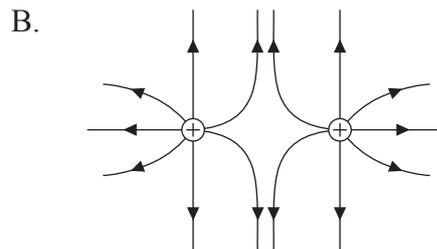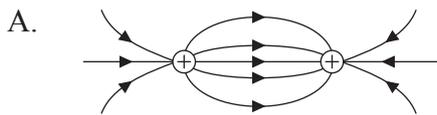
20. An electron of mass m_e and charge e accelerates between two plates separated by a distance s in a vacuum. The potential difference between the plates is V.
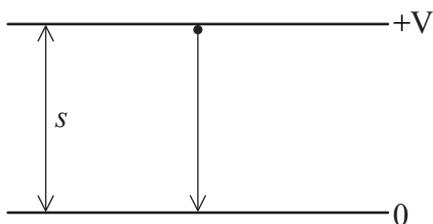

What is the acceleration of the electron?

A. $\dfrac{m_e e V}{s}$

B. $\dfrac{m_e V}{es}$

C. $\dfrac{eV}{m_e s}$

D. $\dfrac{V}{m_e es}$

21. A ball is thrown from the top of a cliff. The initial magnitude of the velocity of the ball at time $t=0$ is V. The ball hits the sea at time $t=T$. Air resistance is negligible.


path of ball

sea
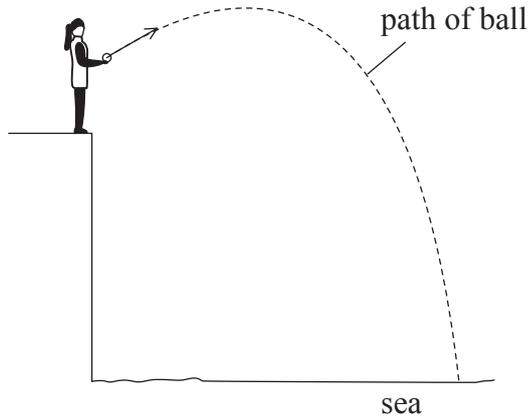
Which graph shows how the **vertical** component of the velocity v of the ball varies with t as it falls to the sea?

A.

B.

C.

D.
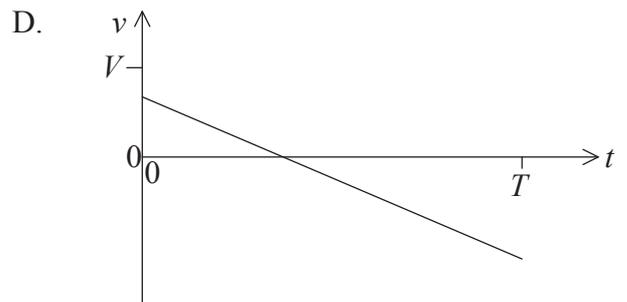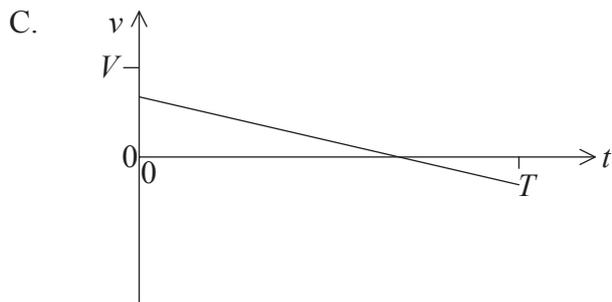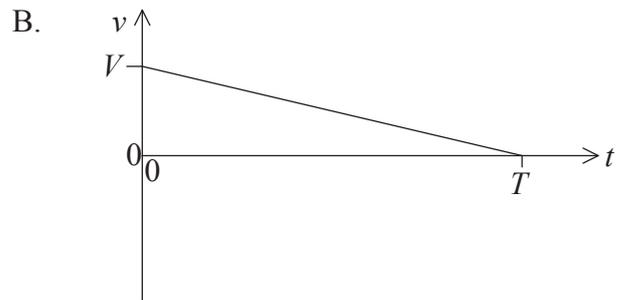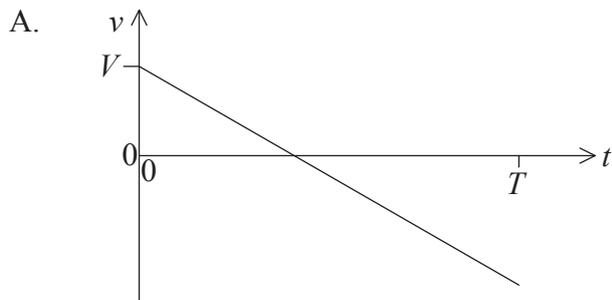
22. A satellite is in orbit about Earth at a distance r from the centre of Earth. The gravitational potential energy of the satellite is E_P and its kinetic energy is E_K. The radius of Earth is R_E. Which graph shows how both E_P and E_K vary with r?

A.

B.

C.

D.
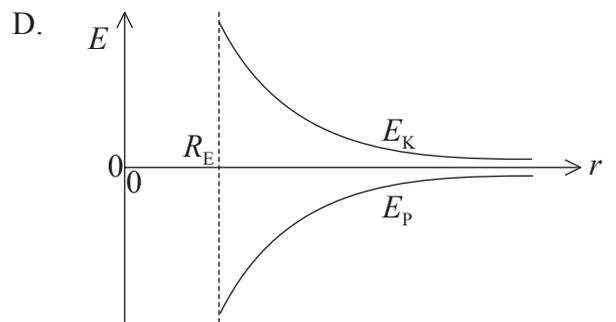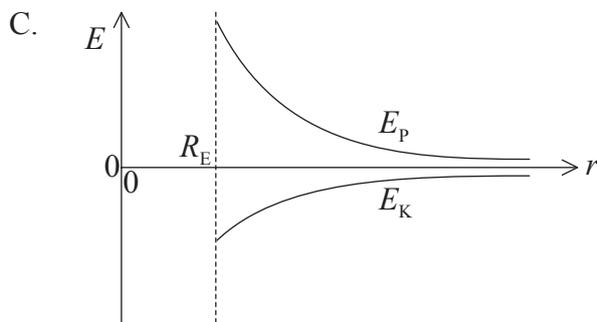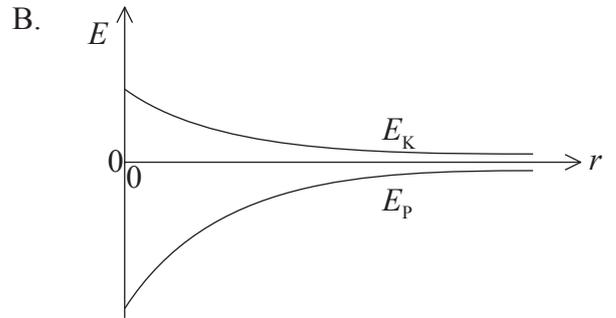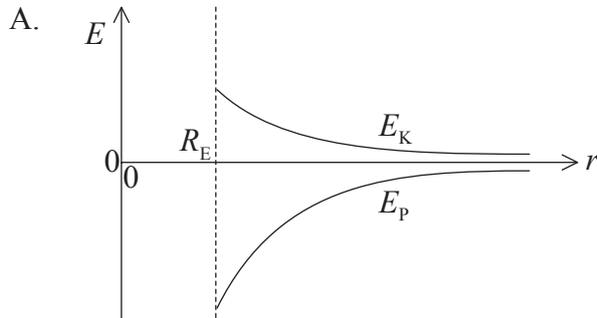
23. The graph shows the variation with distance r of the electric potential V for a positively charged hollow sphere of radius R.
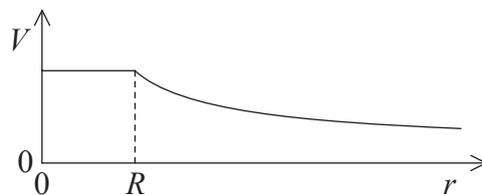
Which graph shows how the magnitude of the electric field E varies with r?

A.

B.

C.

D.
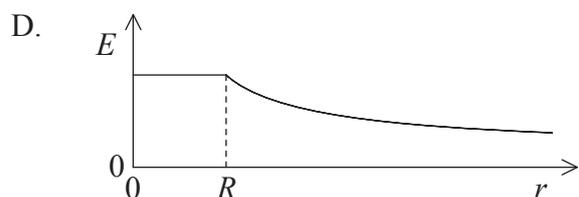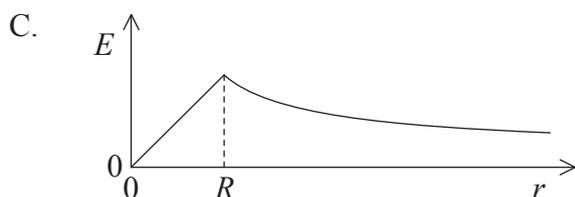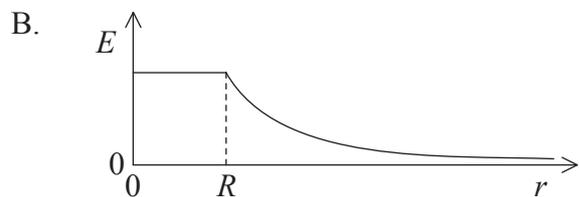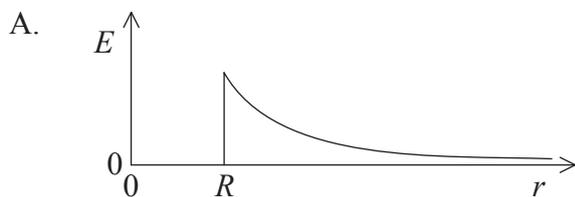
24. An emf of maximum value ε is induced in a coil for a particular rate of change of flux. What will be the maximum emf induced in a coil of the same area but with twice the number of turns when the rate of change of flux is reduced by a factor of four?

    A. 2ε

    B. $\dfrac{\varepsilon}{2}$

    C. $\dfrac{\varepsilon}{4}$

    D. $\dfrac{\varepsilon}{8}$

25. A metal rod M is falling vertically within a horizontal magnetic field. The metal rod and magnetic field are directed into the paper. What is the direction of the initial force acting on the metal rod that is predicted by Lenz's law?

B. Direction of motion

A. ← (M) → C.

D.
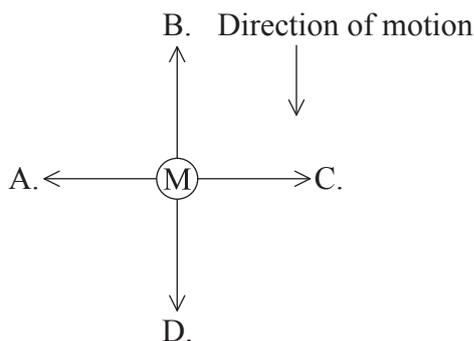
26. In a particular atom, the nucleon number is the total number of

    A.   protons.

    B.   neutrons.

    C.   electrons.

    D.   protons and neutrons.

27. The nuclear reaction represented by

$$_0^1 n + \,_{92}^{235} U \rightarrow \,_{56}^{141} Ba + \,_{36}^{92} Kr + 3\,_0^1 n$$
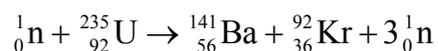
is an example of

A.   nuclear fusion.

B.   nuclear fission.

C.   artificial transmutation.

D.   radioactive decay.

28. When the cathode of a photoelectric cell is illuminated with red light, a photoelectric current is produced in the cell. The illumination is changed to blue light but the rate at which photons arrive at the cathode remains the same. Which of the following statements is/are correct under these conditions?

    I.   The number of electrons released is unchanged

    II.   The current falls to zero

    III.   The kinetic energy of the electron increases

A.   I only

B.   III only

C.   I and II only

D.   I and III only

Turn over

29. The diagram shows the three lowest energy levels of an atom.

——————————————— X

——————————

increasing energy

——————————
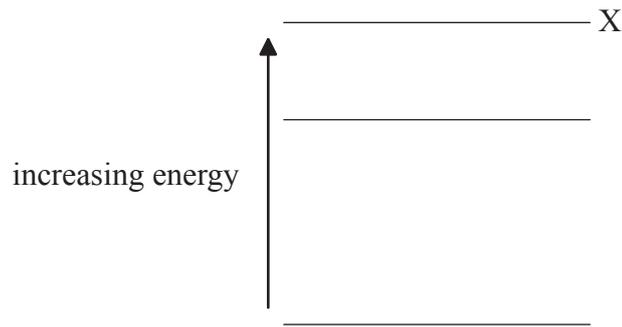
Which diagram shows the emission line spectrum associated with electron transitions from energy level X?

A.   increasing λ

B.   increasing λ

C.   increasing λ

D.   increasing λ
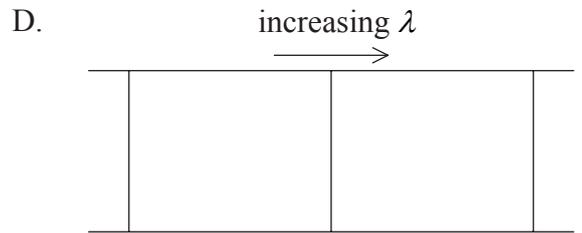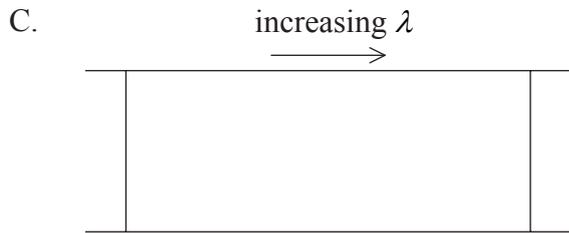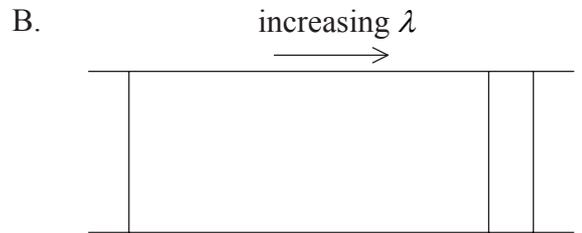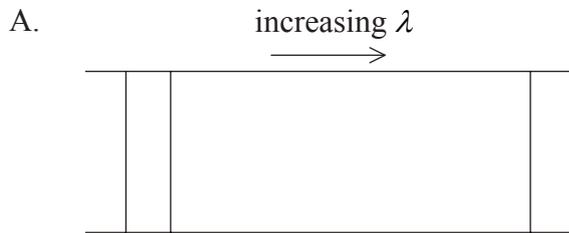
30. In the Heisenberg uncertainty principle, conjugate quantities are pairs of quantities that cannot both be known precisely at the same instant. What unit is used for the product of the conjugate quantities?

A. $kg\,m^2\,s^{-3}$

B. $kg\,m^2\,s^{-2}$

C. $kg\,m^2\,s^{-1}$

D. $kg\,m^2\,s$

31. In a Bainbridge mass spectrometer, which of the following gives the type of fields used for ion speed selection and ion deflection?

	Ion speed selection	**Ion deflection**
A.	electric field only	electric field only
B.	electric and magnetic field	electric field only
C.	electric field only	magnetic field only
D.	electric and magnetic field	magnetic field only

32. Uranium-238 $\left(^{238}_{92}\text{U}\right)$ forms a nucleus of plutonium-239 $\left(^{239}_{94}\text{Pu}\right)$ as a result of

   A.   electron capture followed by alpha decay.

   B.   electron capture followed by beta decay.

   C.   neutron capture followed by alpha decay.

   D.   neutron capture followed by two beta decays.

33. The decay constant is the probability of the

   A.   number of radioactive decays per unit time.

   B.   decay of a nucleus per unit time.

   C.   decay of a nucleus.

   D.   number of nuclei decaying in any given time.

34. In the production of electric power, an advantage of using photovoltaic cells rather than fossil fuels is that the photovoltaic cells

A.   can be effective in any location.

B.   can be used continuously.

C.   have low initial set-up costs.

D.   are more environmentally friendly when in use.

35. A metal sphere X of radius R has an equilibrium surface temperature T. Another sphere Y made of the same metal has a radius $\dfrac{R}{2}$ and an equilibrium surface temperature $2T$. What is the value of the ratio shown below?

$$\frac{\text{power emitted by Y}}{\text{power emitted by X}}$$

A.   8

B.   4

C.   0.5

D.   0.25

36. A liquid has a coefficient of volume expansion of $1 \times 10^{-3}\,\text{K}^{-1}$. What is the percentage decrease in volume of the liquid when the temperature drops by $20\,\text{K}$?

A.   0.02

B.   0.2

C.   2

D.   20

37. Which option is **not** a possible solution to reduce the enhanced greenhouse effect?

    A. Decommission nuclear power plants

    B. Replace the use of coal and oil with natural gas

    C. Use combined heating and power (CHP) systems

    D. Use hybrid motor vehicles

38. What is the 5-bit binary form of the decimal number 23?

    A. 10111

    B. 11101

    C. 11110

    D. 01000

39. Capacitance of a capacitor is defined as the

    A. ability to store electrical charge.

    B. ratio of charge stored to potential difference.

    C. ratio of potential difference to charge stored.

    D. ratio of work done to charged stored.

40. For every 12 photons incident on a pixel of a particular charge-coupled device (CCD), 8 photoelectrons are emitted. What is the quantum efficiency of the pixel?

    A. 33%

    B. 67%

    C. 96%

    D. 150%