

**Physics**  
**Higher level**  
**Paper 1**

Friday 8 May 2015 (morning)

1 hour

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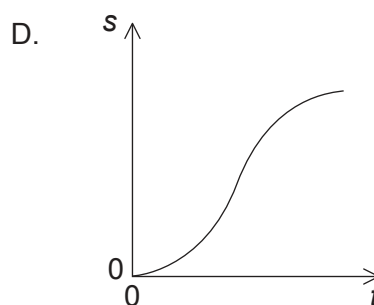
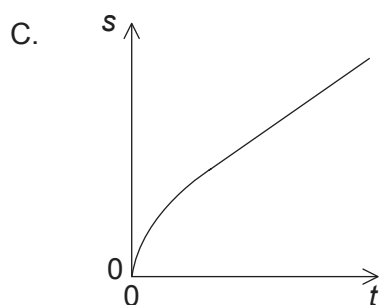
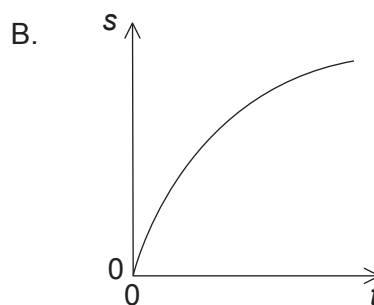
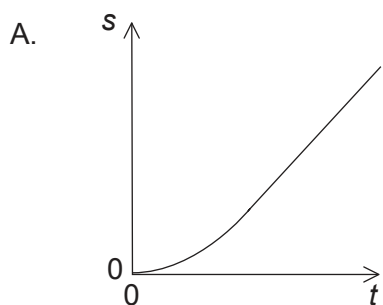
**Instructions to candidates**

- 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. Which unit is equivalent to  $\text{J kg}^{-1}$ ?

- A.  $\text{m s}^{-1}$
- B.  $\text{m s}^{-2}$
- C.  $\text{m}^2 \text{s}^{-1}$
- D.  $\text{m}^2 \text{s}^{-2}$

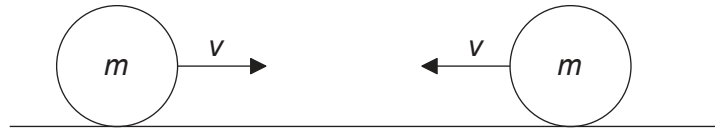
2. A tennis ball is dropped from the top of a tall building. Air resistance is **not** negligible. Which graph shows the variation with time  $t$  of the displacement  $s$  of the ball?



3. Which statement applies to an object in translational equilibrium?

- A. The object must be stationary.
- B. The object must be moving with constant acceleration.
- C. The resultant force acting on the object must be zero.
- D. There must be no external forces acting on the object.

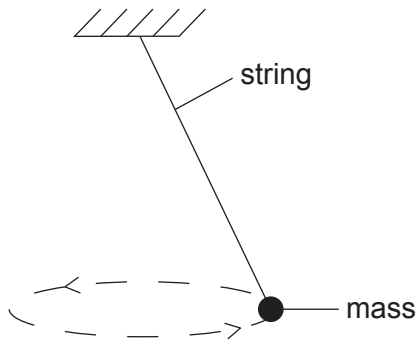
4. Two identical spheres, each of mass  $m$  and speed  $v$ , travel towards each other on a frictionless surface in a vacuum.



The spheres undergo a head-on elastic collision.

Which statement correctly describes the spheres after the collision?

- A. The total momentum of the spheres is  $2mv$ .
  - B. Each sphere has zero momentum.
  - C. The total kinetic energy of the spheres is  $mv^2$ .
  - D. Each sphere has zero kinetic energy.
5. A mass is suspended by a string from a fixed point. The mass moves with constant speed along a circular path in a horizontal plane.



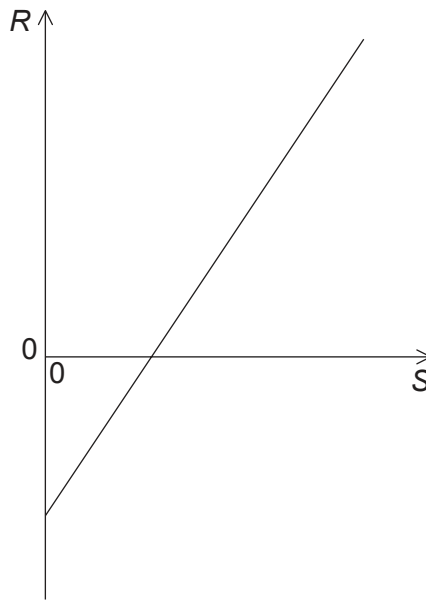
The resultant force acting on the mass is

- A. zero.
- B. directed upwards along the string.
- C. directed towards the centre of the circular path.
- D. in the same direction as the velocity of the mass.

Turn over

6. Which of the following is numerically equal to the specific heat capacity of the substance of a solid body?
- A. The thermal energy required to melt the body
  - B. The thermal energy required to increase the temperature of unit mass of the body by 1K
  - C. The thermal energy required to increase the temperature of the body by 1K
  - D. The total kinetic and potential energy of all the molecules in the body
7. In the kinetic model of an ideal gas, which of the following is **not** assumed?
- A. The molecules collide elastically.
  - B. The kinetic energy of a given molecule is constant.
  - C. The time taken for a molecular collision is much less than the time between collisions.
  - D. The intermolecular potential energy of the molecules is zero.

8. A fixed mass of an ideal gas has a constant volume. Two quantities,  $R$  and  $S$ , of the gas vary as shown by the graph below.



What quantities do  $R$  and  $S$  represent?

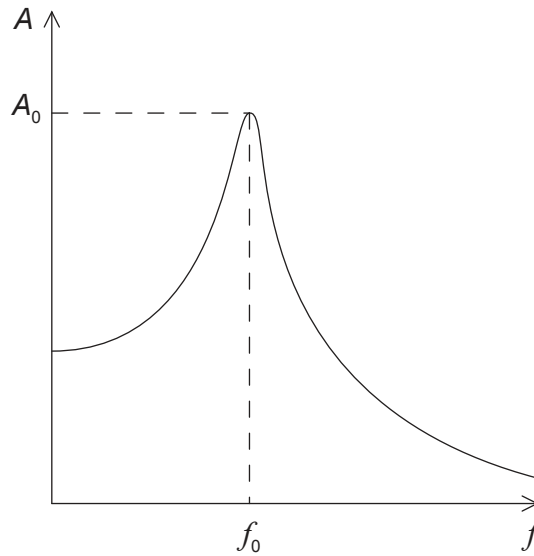
	$R$	$S$
A.	pressure	temperature in kelvin
B.	pressure	temperature in degree Celsius
C.	temperature in kelvin	pressure
D.	temperature in degree Celsius	pressure

9. A fixed mass of an ideal gas undergoes an isochoric (isovolumetric) change. This increases the pressure of the gas. Which describes the change of internal energy of the gas and the direction of transfer of thermal energy?

	Internal energy	Direction of transfer of thermal energy
A.	increase	to the gas
B.	increase	from the gas
C.	decrease	to the gas
D.	decrease	from the gas

Turn over

10. A periodic driving force of frequency  $f$  acts on a system which undergoes forced oscillations of amplitude  $A$ . The graph below shows the variation with  $f$  of  $A$ . The maximum amplitude  $A_0$  of the oscillations occurs at frequency  $f_0$ .

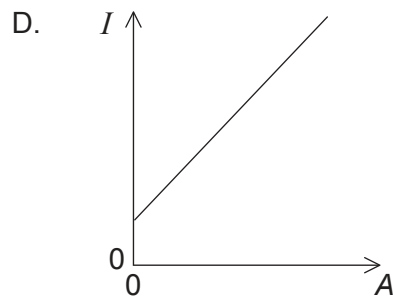
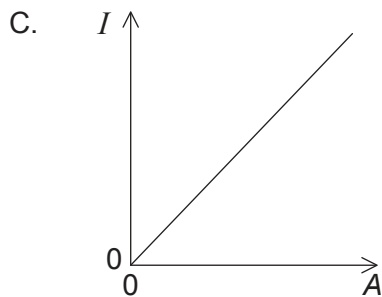
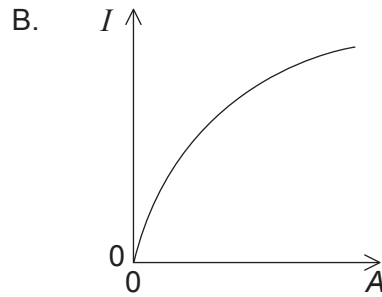
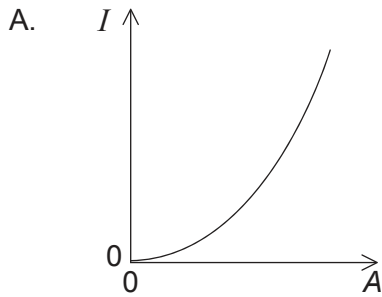


The damping of the system is now increased.

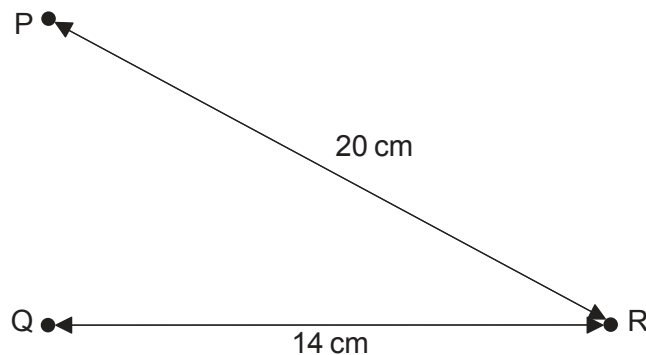
Which describes the change in  $f_0$  and the change in  $A_0$ ?

	$f_0$	$A_0$
A.	decrease	increase
B.	decrease	decrease
C.	increase	increase
D.	increase	decrease

11. Which graph shows the variation with amplitude  $A$  of the intensity  $I$  for a wave?



12. Wave generators placed at position P and position Q produce water waves of wavelength 4.0 cm. Each generator, operating alone, produces a wave oscillating with amplitude  $A$  at position R. Distances PR and QR are shown in the diagram below.

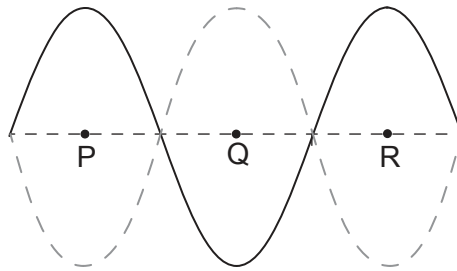


Both wave generators now operate together in phase. What is the amplitude of the oscillation of the resulting wave at R?

- A. 0
- B.  $A$
- C.  $A^2$
- D.  $2A$

Turn over

13. A standing (stationary) wave is set up on a stretched string. The diagram below shows the string at three different instants of time. P, Q and R are three points on the string.



Which of the following gives two points on the string that are in phase and two points on the string that are one wavelength apart?

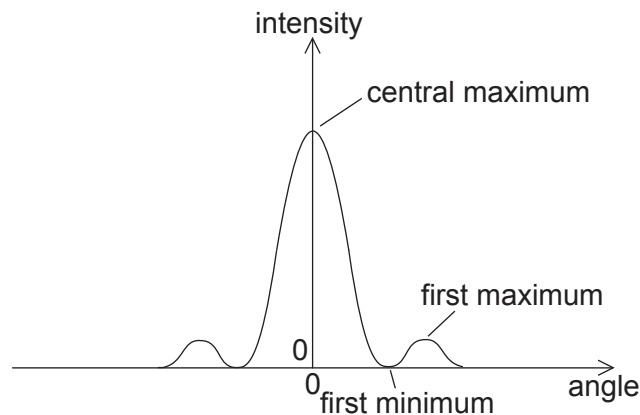
	In phase	One wavelength apart
A.	P and Q	P and R
B.	P and R	P and R
C.	P and Q	P and Q
D.	P and R	P and Q

14. A car horn emits sound of frequency  $f$ . While the horn is sounding, the car moves in a straight line towards a stationary observer. The speed of the car is  $0.10v$  where  $v$  is the speed of sound. What is the frequency of the sound of the horn heard by the observer?

- A.  $\frac{f}{0.90}$
- B.  $1.1f$
- C.  $\frac{f}{1.1}$
- D.  $0.90f$



15. The graph below shows the variation of the intensity of light with angle for the diffraction pattern produced when light is diffracted by a slit.

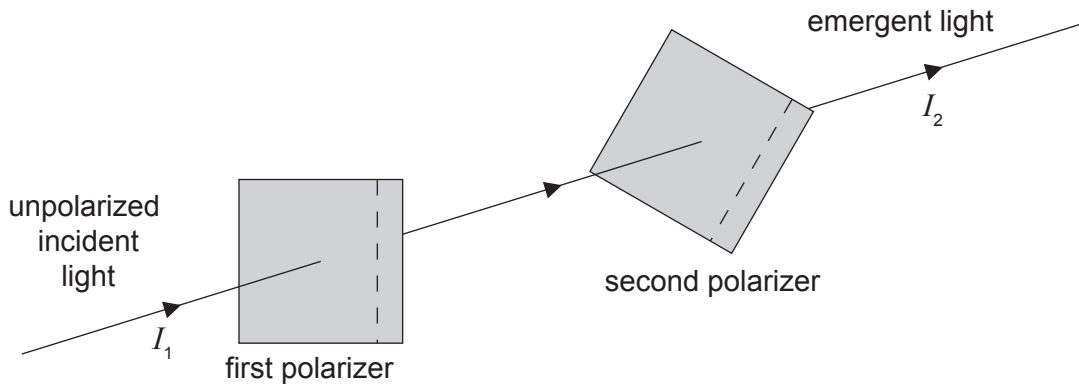


According to the Rayleigh criterion, when the diffraction patterns of two slits are just resolved

- A. the first maximum of one diffraction pattern coincides with the central maximum of the other diffraction pattern.
  - B. the central maximum of one diffraction pattern coincides with the central maximum of the other diffraction pattern.
  - C. the first minimum of one diffraction pattern coincides with the central maximum of the other diffraction pattern.
  - D. the first minimum of one diffraction pattern coincides with the first minimum of the other diffraction pattern.
16. An unpolarized ray of light in air is incident on the surface of water. The reflected ray is completely polarized. Which of the following are separated by an angle of  $90^\circ$ ?
- A. The incident ray and the reflected ray
  - B. The reflected ray and the refracted ray
  - C. The refracted ray and the incident ray
  - D. The refracted ray and the surface of the water

Turn over

17. Two polarizers have polarizing axes that make an angle of  $30^\circ$  to each other. Unpolarized light of intensity  $I_1$  is incident on the first polarizer so that light of intensity  $I_2$  emerges from the second polarizer, as shown below.



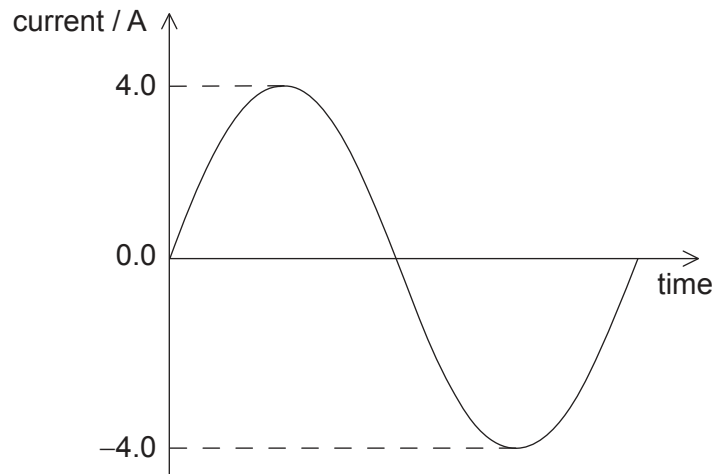
The cosine of  $30^\circ$  is  $\frac{\sqrt{3}}{2}$ . What is the ratio  $\frac{I_1}{I_2}$ ?

- A.  $\frac{3}{8}$
  - B.  $\frac{4}{3}$
  - C.  $\frac{4}{\sqrt{3}}$
  - D.  $\frac{8}{3}$
18. A wire of uniform circular cross-section is replaced in an electrical circuit. The new wire has the same length and same resistance but half the diameter of the old wire.

What is the ratio  $\frac{\text{resistivity of the new wire}}{\text{resistivity of the old wire}}$ ?

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

19. A circuit is formed by connecting a resistor between the terminals of a battery of electromotive force (emf) 6 V. The battery has internal resistance. Which statement is correct when 1 C of charge flows around the complete circuit?
- A. 6 V is the potential difference across the resistor.
  - B. 6 J of thermal energy is dissipated in the battery.
  - C. 6 J of chemical energy is transformed in the battery.
  - D. 6 J of thermal energy is dissipated in the resistor.
20. Faraday's law of electromagnetic induction states that the electromotive force (emf) induced in a conductor is proportional to
- A. the change of magnetic flux density.
  - B. the change of magnetic flux linkage.
  - C. the rate of change of magnetic flux density.
  - D. the rate of change of magnetic flux linkage.
21. The graph below shows the variation with time of an alternating current in a resistor of resistance  $2.0\ \Omega$ .



What is the average power dissipated in the resistor?

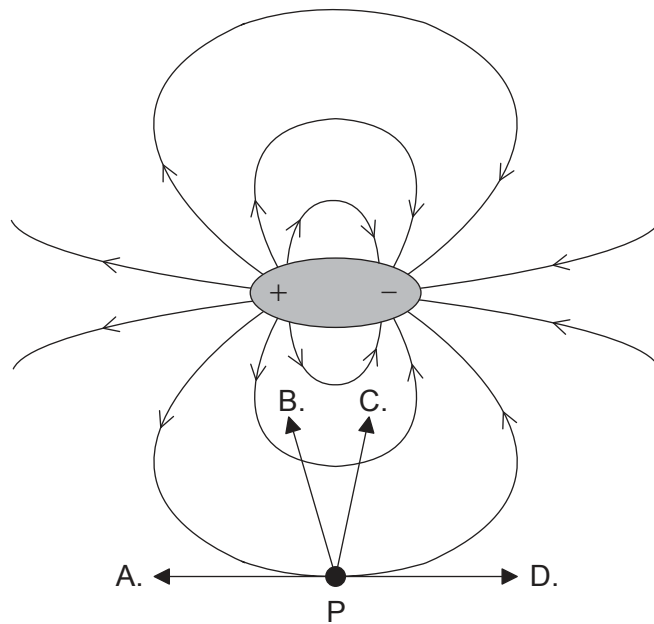
- A. 0.25 W
- B. 8.0 W
- C. 16 W
- D. 32 W

Turn over

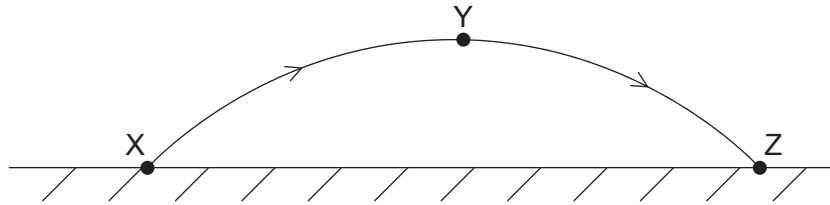
22. Which single condition enables Newton's universal law of gravitation to be used to predict the force between the Earth and the Sun?
- A. The Earth and the Sun both have a very large radius.
  - B. The distance between the Earth and the Sun is approximately constant.
  - C. The Earth and the Sun both have a very large mass.
  - D. The Earth and the Sun behave as point masses.

23. An electric dipole consists of a positive and a negative charge separated by a fixed distance. The electric field due to the dipole is shown in the diagram below.

An electric force acts on an electron at point P. In which direction does this force act?



24. A ball is thrown from point X and follows path XYZ. Air resistance is negligible.

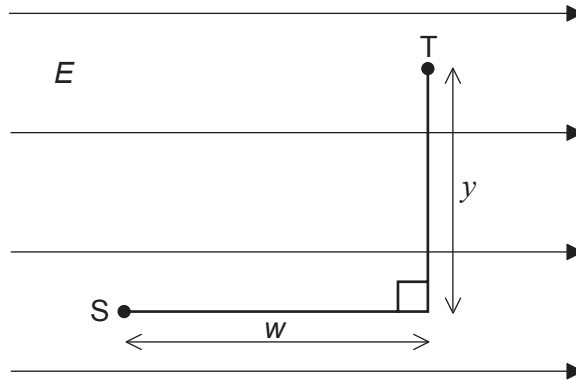


Which quantity is zero when the ball is at the highest point Y of the path?

- A. The horizontal component of the ball's acceleration
  - B. The vertical component of the ball's acceleration
  - C. The horizontal component of the ball's velocity
  - D. The kinetic energy of the ball
25. Two isolated spherical planets have the same gravitational potential at their surfaces. Which ratio must also be the same for the two planets?
- A.  $\frac{\text{radius}^3}{\text{mass}}$
  - B.  $\frac{\text{radius}^2}{\text{mass}}$
  - C.  $\frac{\text{radius}}{\text{mass}}$
  - D. radius

Turn over

26. A particle of charge  $q$  is at point S in a uniform electric field of strength  $E$ . The particle moves a distance  $w$  parallel to the field lines and then a distance  $y$  perpendicular to the field lines to reach point T.



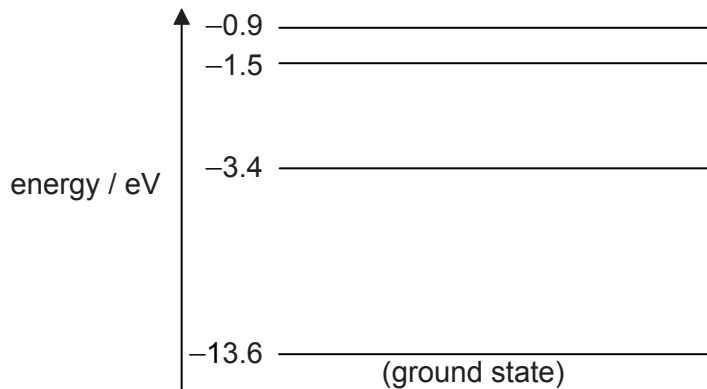
What is the change in electric potential energy of the charge between S and T?

- A.  $Eqw$
- B.  $Eqy$
- C.  $Eq(y + w)$
- D.  $Eq\sqrt{y^2 + w^2}$
27. Nucleus P decays by a sequence of emissions to form nucleus Q. One  $\alpha$  particle and two  $\beta^-$  particles are emitted during the sequence. Which statement is correct?
- A. Nucleus P has the same number of neutrons as nucleus Q.
- B. Nucleus P is an isotope of nucleus Q.
- C. Nucleus P has a greater charge than nucleus Q.
- D. Nucleus P has fewer protons than nucleus Q.
28. In a nuclear fission reaction, nucleus X splits into nucleus Y and nucleus Z.
- Which of the following gives a possible order of the nuclei from lowest to highest binding energy per nucleon?
- A.  $Z \rightarrow Y \rightarrow X$
- B.  $Z \rightarrow X \rightarrow Y$
- C.  $Y \rightarrow X \rightarrow Z$
- D.  $X \rightarrow Z \rightarrow Y$

29. Photoelectrons are emitted at a certain rate when monochromatic light is incident on a metal surface. Light of the same intensity but of higher frequency is now used. After this change, the rate of emission of electrons from the surface is
- A. zero.
  - B. lower.
  - C. the same.
  - D. higher.
30. Which phenomenon provides evidence for the wave nature of an electron?
- A. Line spectra of atoms
  - B. Photoelectric effect
  - C. Beta decay of nuclei
  - D. Scattering of electrons by a crystal

Turn over

31. Some of the energy levels for a hydrogen atom are shown in the diagram.



The table shows four photons with their corresponding energies.

Photon	Energy / eV
W	8.6
X	10.2
Y	12.1
Z	12.6

Each photon is incident on a hydrogen atom in its ground state. Which photons could be absorbed by the atom?

- A. W only
  - B. X and Y only
  - C. Y and Z only
  - D. X, Y and Z only
32. An ion follows a circular path in a uniform magnetic field. Which single change decreases the radius of the path?
- A. Increasing the mass of the ion
  - B. Increasing the charge of the ion
  - C. Increasing the speed of the ion
  - D. Decreasing the magnetic flux density of the field



33. A particular radioactive substance decays and emits both  $\beta^+$  particles and neutrinos. Which describes the nature of the energy spectrum of the  $\beta^+$  particles and the nature of the energy spectrum of the neutrinos?

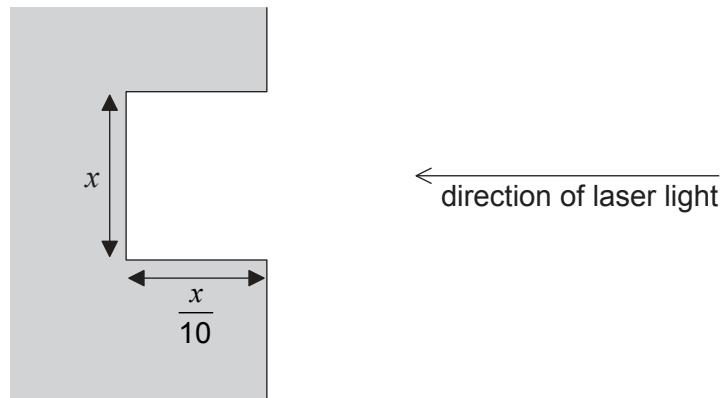
	Energy spectrum of $\beta^+$ particles	Energy spectrum of neutrinos
A.	discrete	discrete
B.	discrete	continuous
C.	continuous	discrete
D.	continuous	continuous

34. In nuclear power production, what is one advantage of a nuclear fusion reactor over a nuclear fission reactor?
- A. The operating temperature of the fusion reactor is lower.
  - B. The nuclear reactants are more easily confined within the core of the fusion reactor.
  - C. The disposal of the nuclear waste products from the fusion reactor is more straightforward.
  - D. The nuclear fusion reaction is more easily sustained for long periods of time.
35. Which type of power-production system is most suitable for responding to a sudden high increase in demand for electrical power?
- A. A wind generator
  - B. A tidal water storage hydroelectric scheme
  - C. An ocean-wave energy converter
  - D. A pump storage hydroelectric scheme
36. The surface heat capacity of a planet is the energy required to raise by 1 K the temperature of
- A. unit area of the surface.
  - B. unit volume of the surface.
  - C. unit mass of the surface.
  - D. the whole surface.

Turn over

37. Which could increase the rate of global warming?
- A. Replacing fossil fuel power stations with nuclear reactors
  - B. Replacing gas-fired power stations with coal-fired power stations
  - C. Using carbon dioxide capture and storage at power stations
  - D. Replacing conventional fossil fuel power stations with combined heating and power (CHP) systems

38. Radiation from a laser is used to recover the information stored on a CD. The diagram below shows a cross-section through a pit on the CD and the incident direction of the laser light.



What is the wavelength of the laser light?

- A.  $\frac{x}{5}$
- B.  $\frac{x}{4}$
- C.  $\frac{2x}{5}$
- D.  $4x$

39. Which of the following gives the equivalent decimal number and the least-significant bit (LSB) of the binary number 11010?

	Decimal number	LSB
A.	11	0
B.	11	1
C.	26	0
D.	26	1

40. A pixel of a charge-coupled device (CCD) has a capacitance of 10 pF. The potential difference across the pixel is 160  $\mu$ V. How many electrons are stored by the pixel?

- A.  $10^4$   
B.  $10^7$   
C.  $10^{10}$   
D.  $10^{16}$
-