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**PHYSICS
HIGHER LEVEL
PAPER 1**

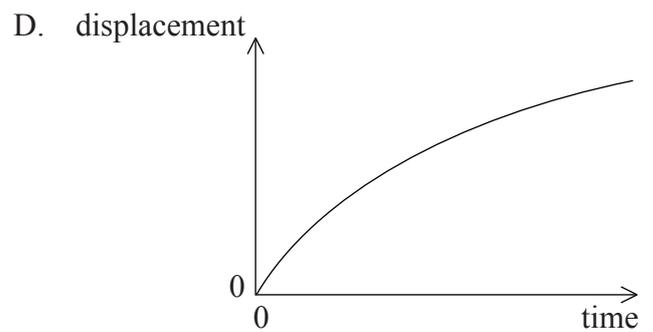
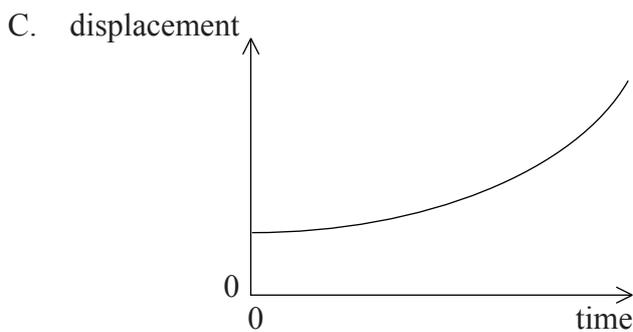
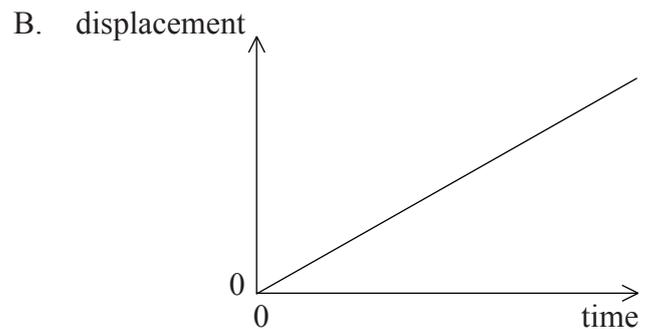
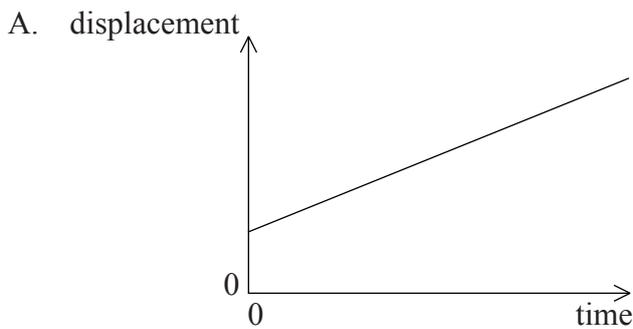
Wednesday 7 May 2014 (morning)

1 hour

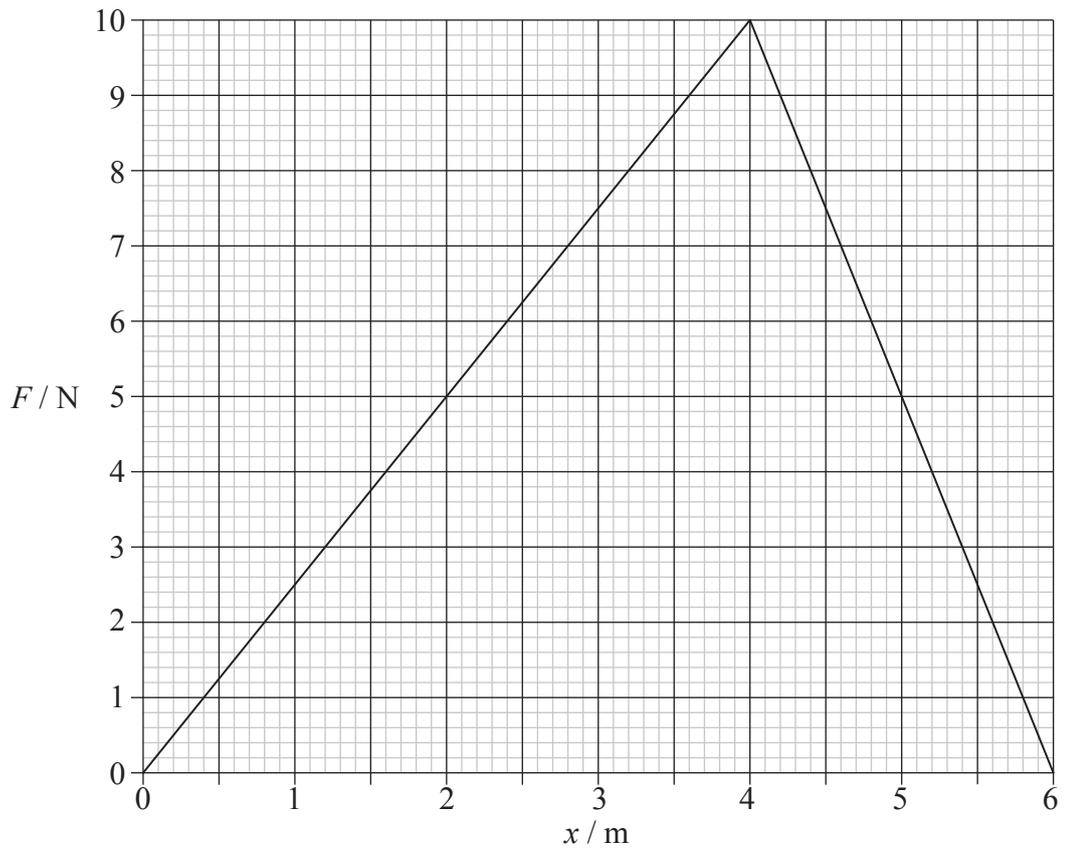
INSTRUCTIONS TO CANDIDATES

- 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 force of air resistance F that acts on a car moving at speed v is given by $F = kv^2$ where k is a constant. What is the unit of k ?
- A. kg m^{-1}
B. $\text{kg m}^{-2} \text{s}^2$
C. kg m^{-2}
D. $\text{kg m}^{-2} \text{s}^{-2}$
2. The volume V of a cylinder of radius R and height H is given by $V = \pi R^2 H$. The volume of the cylinder was measured with an uncertainty of 10% and the height was measured with an uncertainty of 6%. What is the uncertainty in the radius of the cylinder?
- A. 1%
B. 2%
C. 4%
D. 8%
3. A body moves on a straight line. The graphs show the variation of displacement with time. Which graph shows motion with non-zero acceleration and non-zero initial velocity?



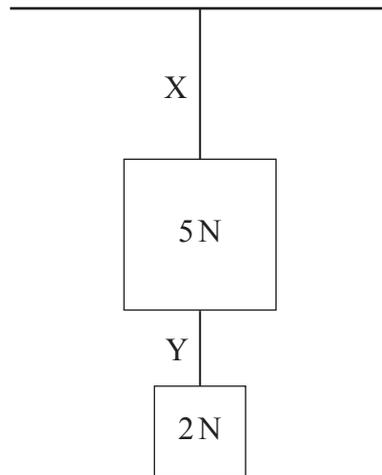
4. The graph shows how the net force F that acts on a body varies with the distance x that the body has travelled.



After travelling 6 m, the change in the kinetic energy of the body is

- A. 0J.
- B. 20J.
- C. 30J.
- D. 60J.

5. Two blocks of weight 5 N and 2 N are attached to two ropes, X and Y.

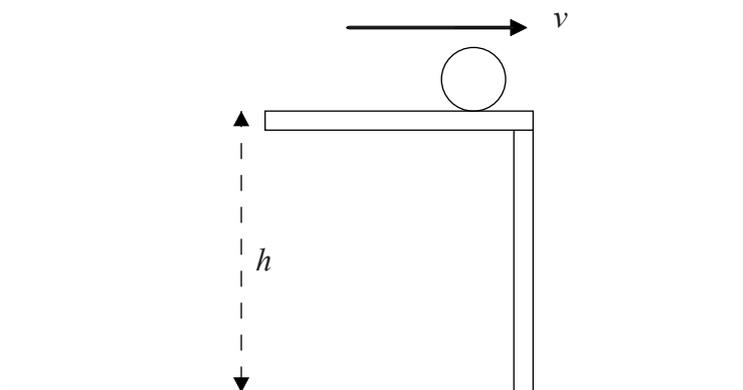


The blocks hang vertically. The mass of the ropes is negligible. What is the tension in X and the tension in Y?

	Tension in X	Tension in Y
A.	7 N	7 N
B.	7 N	2 N
C.	5 N	2 N
D.	5 N	3 N

6. The maximum speed with which a car can take a circular turn of radius R is v . The maximum speed with which the same car, under the same conditions, can take a circular turn of radius $2R$ is
- A. $2v$.
 - B. $v\sqrt{2}$.
 - C. $4v$.
 - D. $2v\sqrt{2}$.

7. A ball of mass m is projected horizontally with speed v from a height h above the floor. Air resistance is negligible.



The horizontal distance travelled by the ball to the point where it lands on the floor depends on

- A. m and h only.
 - B. m and v only.
 - C. h and v only.
 - D. m , h and v .
8. A field line is normal to an equipotential surface
- A. for both electric and gravitational fields.
 - B. for electric but not gravitational fields.
 - C. for gravitational but not electric fields.
 - D. for neither electric nor gravitational fields.

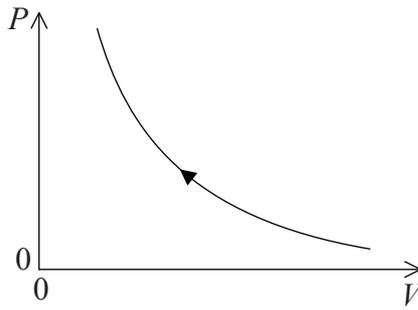
9. The magnitude of the potential at the surface of a planet is V . What is the escape speed from the surface of the planet?
- A. \sqrt{V}
 - B. $\sqrt{2V}$
 - C. \sqrt{VR}
 - D. $\sqrt{2VR}$

10. A fixed mass of water is heated by an electric heater of unknown power P . The following quantities are measured
- I. mass of water
 - II. increase in water temperature
 - III. time for which water is heated.

In order to calculate P , the specific heat capacity of the water is required. Which are also required?

- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III
11. A block of iron of mass 10 kg and temperature 10°C is brought into contact with a block of iron of mass 20 kg and temperature 70°C . No energy transfer takes place except between the two blocks. What will be the final temperature of both blocks?
- A. 30°C
 - B. 40°C
 - C. 50°C
 - D. 60°C

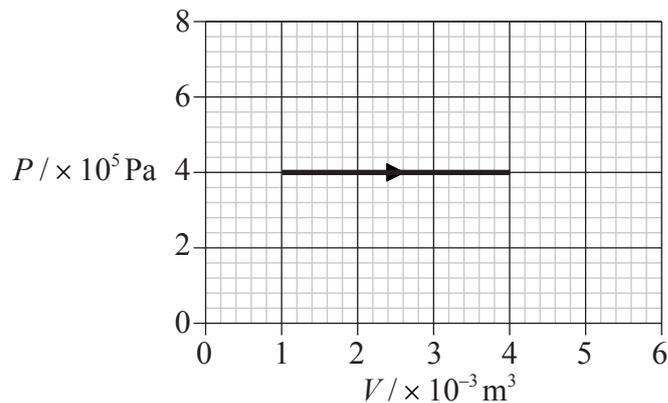
12. The pressure–volume (P – V) graph shows an adiabatic compression of a fixed mass of an ideal gas.



Which of the following correctly describes what happens to the temperature and the internal energy of the gas during the compression?

	Temperature	Internal energy
A.	decreases	decreases
B.	increases	no change
C.	decreases	no change
D.	increases	increases

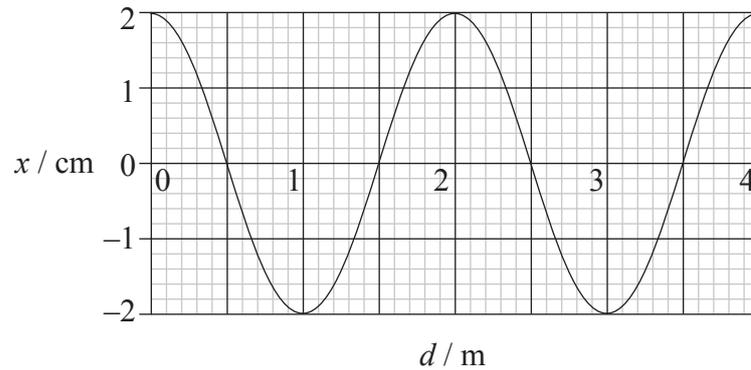
13. An ideal gas expands at constant pressure. The graph shows the relationship between pressure P and volume V for this change.



The change in the internal energy of the gas during this expansion is 1800 J. What is the amount and the direction of thermal energy transferred?

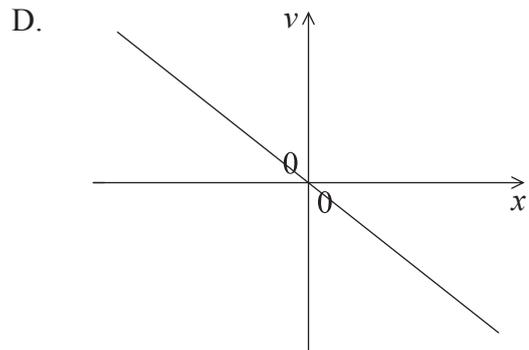
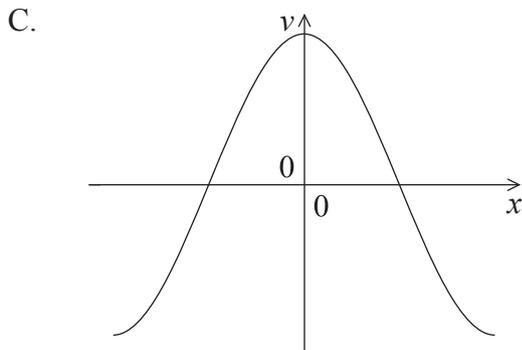
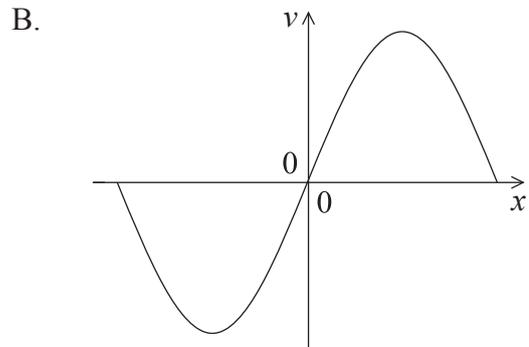
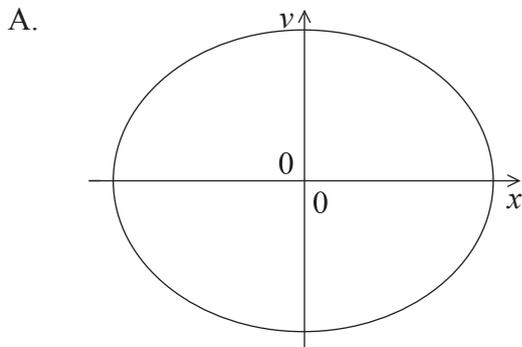
- A. 3000 J into the gas
- B. 3000 J out of the gas
- C. 600 J into the gas
- D. 600 J out of the gas

14. A wave of period 5.0 ms travels through a medium. The graph shows the variation with distance d of the displacement x of points in the medium.

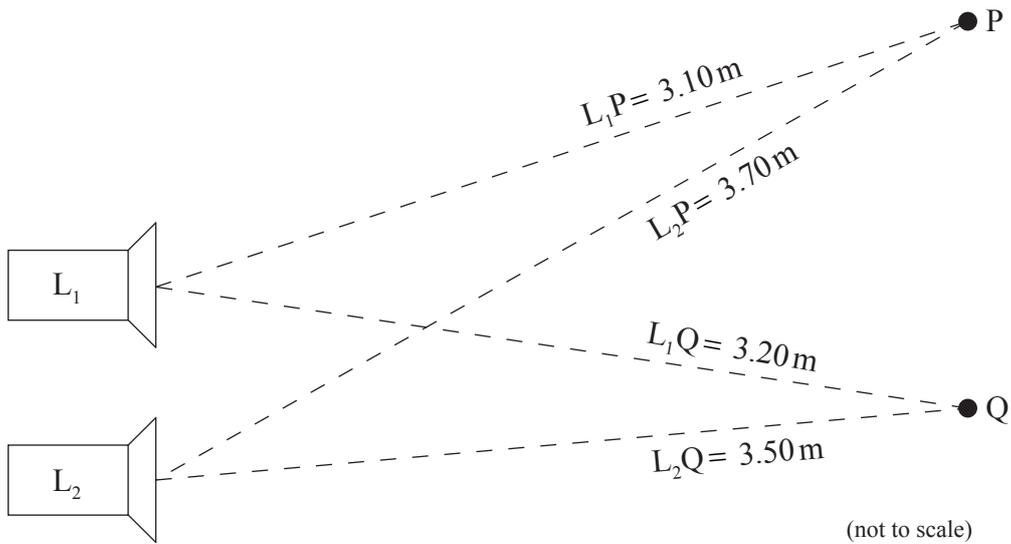


What is the average speed of a point in the medium during one full oscillation?

- A. 0 ms^{-1}
 - B. 4.0 ms^{-1}
 - C. 16 ms^{-1}
 - D. 400 ms^{-1}
15. A body undergoes simple harmonic motion. Which graph correctly shows the variation with displacement x of the velocity v of the body?



16. Two loudspeakers, L_1 and L_2 , emit identical sound waves.



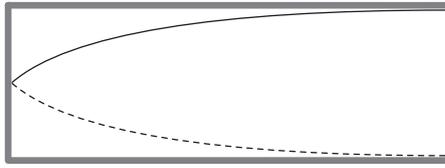
The waves leaving L_1 and L_2 are in phase and are observed at points P and Q.

The wavelength of the sound is 0.60 m. The distances of points P and Q from the loudspeakers are shown in the diagram.

Which of the following is true about the intensity of the sound at P and the intensity of the sound at Q?

	Intensity at P	Intensity at Q
A.	maximum	maximum
B.	maximum	minimum
C.	minimum	maximum
D.	minimum	minimum

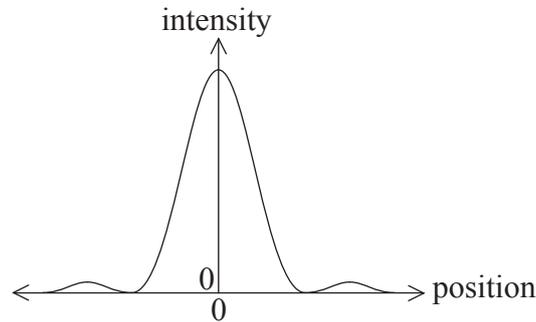
17. The diagram shows the fundamental (first harmonic) of a standing (stationary) sound wave in a pipe open at one end.



At any instant, all the molecules of air in the pipe oscillate with the same

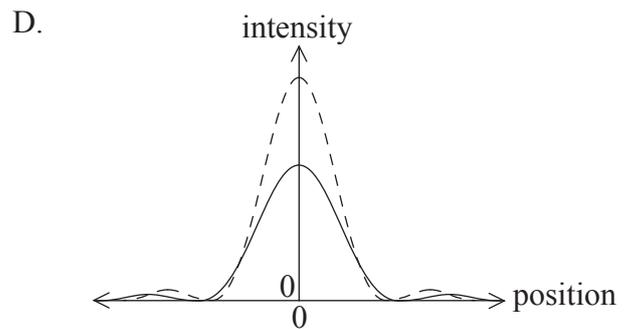
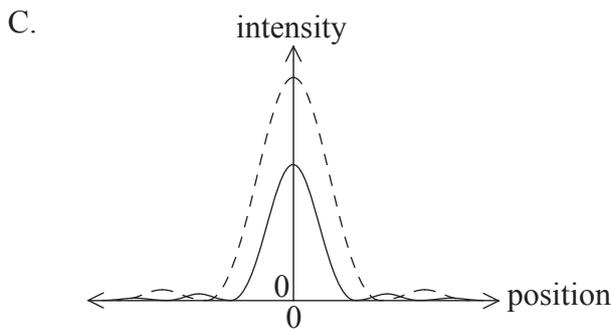
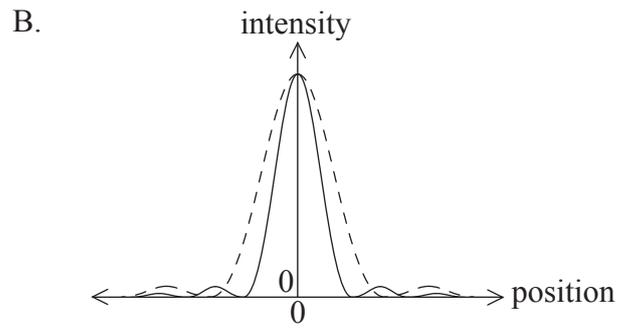
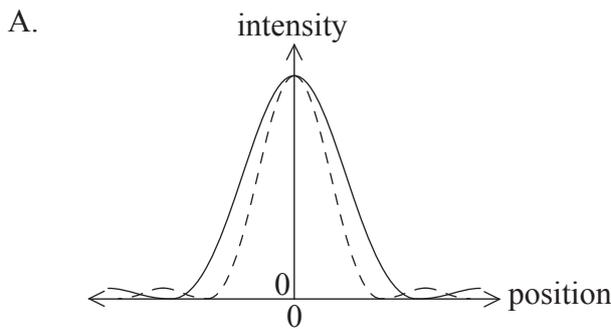
- A. phase.
- B. amplitude.
- C. velocity.
- D. acceleration.

18. Monochromatic coherent light is incident on a narrow rectangular slit. The diffracted light is observed on a distant screen. The graph below shows how the intensity of the light varies with position on the screen.



The width of the slit is reduced.

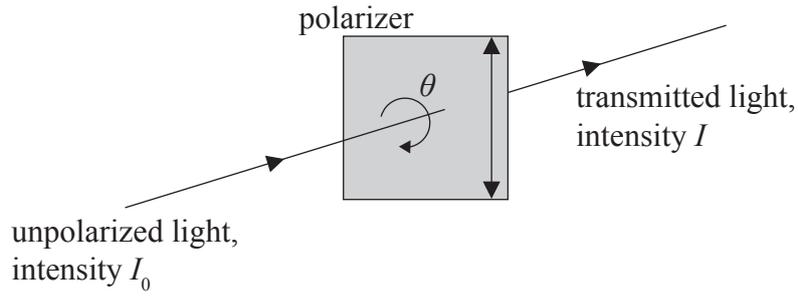
Which graph shows how the intensity of light observed varies with position on the screen? The original diffraction pattern is shown with a dotted line.



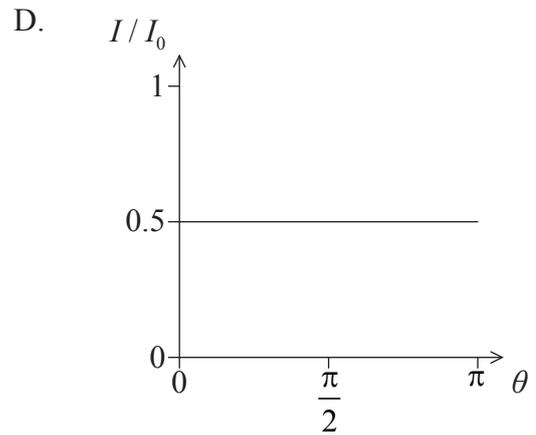
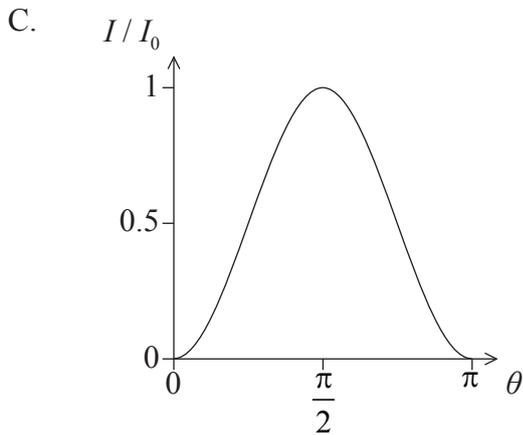
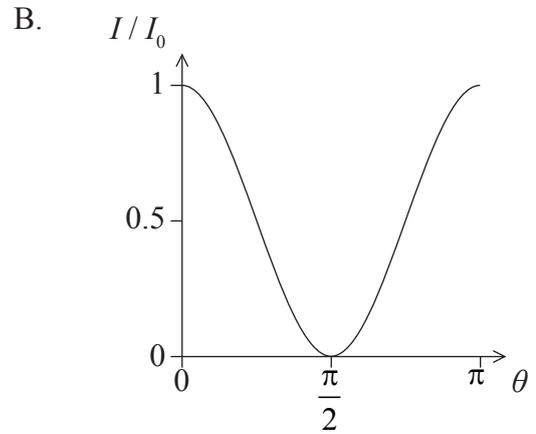
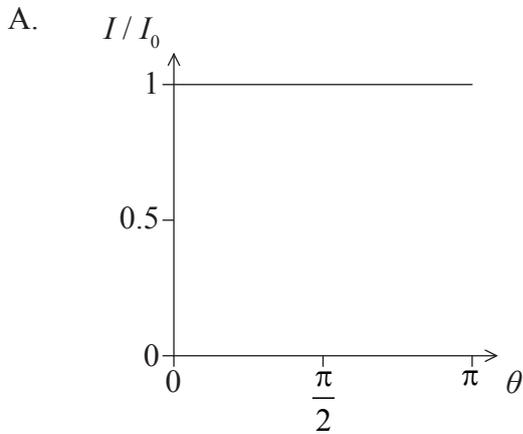
19. Light of wavelength λ_0 is emitted from a nearby galaxy. The light is received on Earth and the wavelength is measured to be λ where $\lambda < \lambda_0$. Which of the following correctly describes the speed and direction of motion of the galaxy?

	Speed	Direction
A.	$\frac{\lambda_0 - \lambda}{\lambda_0} c$	towards earth
B.	$\frac{\lambda_0 - \lambda}{\lambda} c$	towards earth
C.	$\frac{\lambda_0 - \lambda}{\lambda_0} c$	away from earth
D.	$\frac{\lambda_0 - \lambda}{\lambda} c$	away from earth

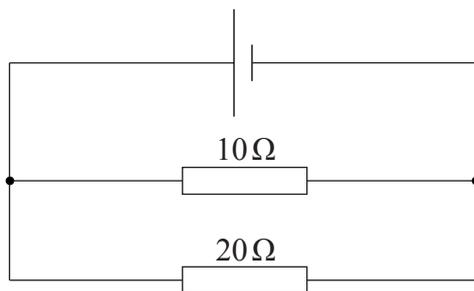
20. Unpolarized light of intensity I_0 is incident on a polarizer that has a vertical transmission axis.



The polarizer is rotated by an angle θ about the direction of the incident light. The intensity of the transmitted light is I . Which graph correctly shows the variation with the angle θ of the ratio $\frac{I}{I_0}$?

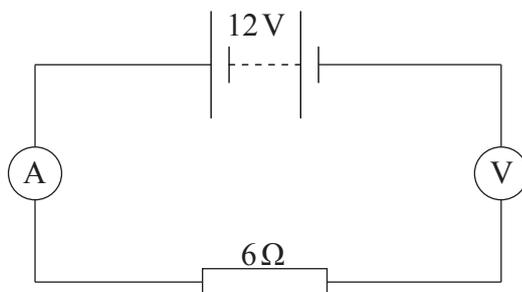


21. Two resistors of resistance 10Ω and 20Ω are connected in parallel to a cell of negligible internal resistance.



The energy dissipated in the 10Ω resistor in one second is Q . What is the energy dissipated in one second in the 20Ω resistor?

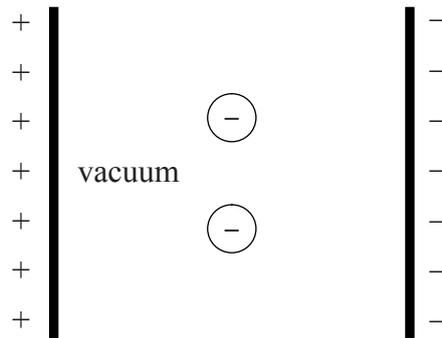
- A. $\frac{Q}{4}$
 B. $\frac{Q}{2}$
 C. $2Q$
 D. $4Q$
22. A battery of emf 12V and negligible internal resistance is connected to a resistor of constant resistance 6Ω , an ideal ammeter and an ideal voltmeter.



What is the reading on the ammeter and on the voltmeter?

	Ammeter reading / A	Voltmeter reading / V
A.	2.0	0
B.	2.0	12
C.	0	0
D.	0	12

23. Two negatively charged particles are released from rest half-way between two oppositely charged parallel plates in vacuum.



The particles take the same time to reach the positively charged plate. The particles must have the same

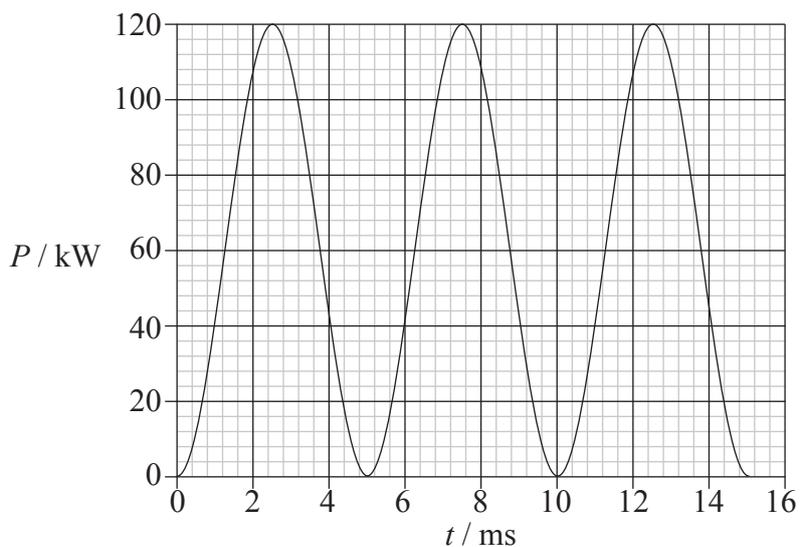
- A. charge only.
 - B. mass only.
 - C. mass and charge.
 - D. ratio of mass to charge.
24. Three parallel wires, X, Y and Z, carry equal currents. The currents in X and Z are directed into the page. The current in Y is directed out of the page.



Which arrow shows the direction of the magnetic force experienced by wire Z?

- A.
- B.
- C.
- D.

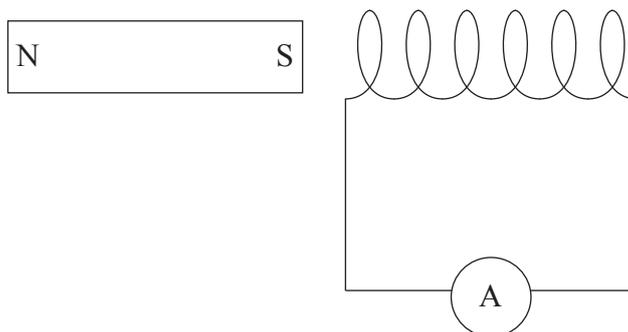
25. The graph shows the variation with time t of the power P produced in a coil that is rotating in a region of uniform magnetic field.



Which of the following describes the average power produced and the period of rotation of the coil?

	Average power	Period
A.	60 kW	5.0 ms
B.	60 kW	10 ms
C.	$\frac{120}{\sqrt{2}}$ kW	5.0 ms
D.	$\frac{120}{\sqrt{2}}$ kW	10 ms

26. A bar magnet is close to a coil. No other magnetic fields are present. An ammeter is connected to the coil.



The magnet and the coil are moved in the following ways.

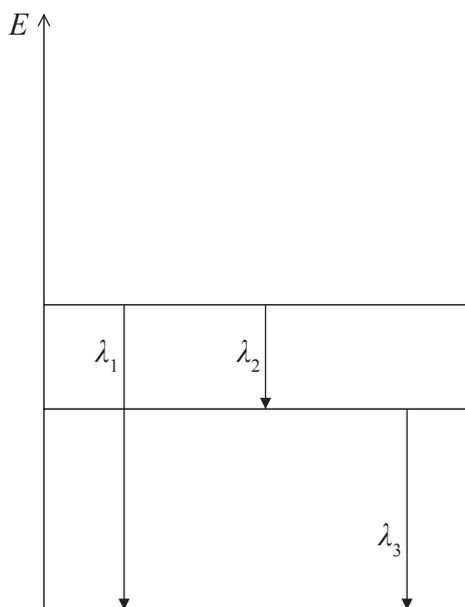
- I. The magnet and the coil both move to the right with the same speed.
- II. The magnet is stationary and the coil moves to the left.
- III. The coil is stationary and the magnet moves to the right.

In which of the following will the ammeter indicate a current?

- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I only
27. The binding energy per nucleon of a ${}^3_1\text{H}$ nucleus is 3 MeV. What is the minimum energy needed to completely separate the nucleons of ${}^3_1\text{H}$?
- A. 12 MeV
 - B. 9 MeV
 - C. 6 MeV
 - D. 3 MeV

28. A radioactive sample has activity A_0 at $t = 0$. What will be the activity of the sample after two half-lives?
- A. zero
 - B. $\frac{A_0}{4}$
 - C. less than $\frac{A_0}{4}$ if the sample is kept at high pressure
 - D. greater than $\frac{A_0}{4}$ if the sample is kept at high temperature

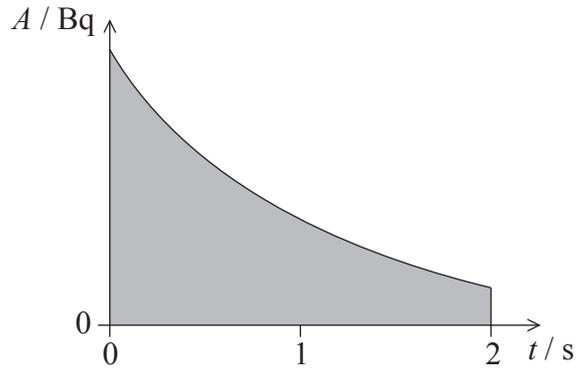
29. The arrows below indicate transitions involving three energy levels of an atom. The wavelength of the photon emitted in each transition is indicated.



Which of the following relationships between the wavelengths is correct?

- A. $\lambda_1 = \lambda_2 + \lambda_3$
- B. $\lambda_1 = \lambda_3 - \lambda_2$
- C. $\frac{1}{\lambda_1} = \frac{1}{\lambda_2} + \frac{1}{\lambda_3}$
- D. $\frac{1}{\lambda_1} = \frac{1}{\lambda_2} - \frac{1}{\lambda_3}$

30. The graph shows the variation with time t of the activity A of a radioactive sample. The energy released in each decay is E . The shaded area is equal to S .



What does the quantity $S \times E$ represent?

- A. Average energy produced in 2 s.
 - B. Average power produced in 2 s.
 - C. Total energy produced in 2 s.
 - D. Maximum power produced in 2 s.
31. An alpha particle is directed head-on towards a nucleus of an isotope of iron. A second alpha particle, with the same energy as the first, is directed head-on towards a different isotope of iron.

Which of the following is a comparison of the distances of closest approach of the two alpha particles and the forces experienced by the alpha particles at the point of closest approach?

	Distances	Forces
A.	same	same
B.	same	different
C.	different	same
D.	different	different

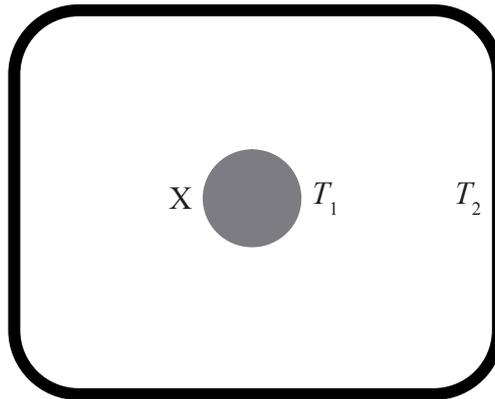
32. The de Broglie wavelength of an electron is equal to the wavelength of a photon that has energy E . What is the momentum of the electron?
- A. $\frac{E}{c}$
- B. $\frac{E}{hc}$
- C. $\frac{hc}{E}$
- D. $\frac{m_e c^2}{hE}$
33. In the “electron in a box” model, an electron is confined to move along a line of length L . What is the smallest possible value of the momentum of the electron?
- A. 0
- B. $\frac{h}{2L}$
- C. $\frac{h}{L}$
- D. $\frac{3h}{2L}$
34. A natural gas power station has an output of 600 MW and an efficiency of 50%. The mass of natural gas that is burned per second is 20 kg. What is the energy density of natural gas?
- A. 15 MJ kg⁻¹
- B. 30 MJ kg⁻¹
- C. 40 MJ kg⁻¹
- D. 60 MJ kg⁻¹
35. Which of the following best defines non-renewable fuels?
- A. They produce a lot of degraded energy in comparison with renewable fuels
- B. They have very high energy density but produce greenhouse gases
- C. They cannot be produced again
- D. Their rate of consumption is much greater than the rate at which they are being produced

36. The average intensity of the solar radiation incident on a planet is 200 W m^{-2} . The albedo of the planet is 0.6. The average temperature of the planet is constant.

Which of the following is a correct statement about the intensity of radiation reflected and radiated by the planet?

	Intensity reflected by planet	Intensity radiated by planet
A.	120 W m^{-2}	80 W m^{-2}
B.	120 W m^{-2}	less than 80 W m^{-2}
C.	80 W m^{-2}	120 W m^{-2}
D.	80 W m^{-2}	less than 120 W m^{-2}

37. A body X of emissivity e is at temperature T_1 . X is inside a box whose walls act as a black body of temperature T_2 . T_1 is greater than T_2 .



What is the net intensity of radiation leaving body X?

- A. σT_1^4
 B. $e\sigma T_1^4$
 C. $e\sigma T_1^4 - \sigma T_2^4$
 D. $e\sigma(T_1^4 - T_2^4)$

38. In a hydroelectric power plant, water of density 10^3 kg m^{-3} falls through an average height of 100 m. The volume of water flowing through the pipes per second is $10 \text{ m}^3 \text{ s}^{-1}$. What is the maximum power generated?
- A. 10^4 W
 - B. 10^5 W
 - C. 10^6 W
 - D. 10^7 W
39. Which wave phenomenon is most closely associated with the reading of the information from a compact disc (CD)?
- A. Diffraction
 - B. Interference
 - C. Refraction
 - D. Polarization
40. Which one of the following changes to the pixels of a charge-coupled device (CCD) will result in an increase in the resolution of the CCD?
- A. A decrease of their capacitance
 - B. A decrease of their size
 - C. An increase of their size
 - D. An increase of their quantum efficiency
-