N06/4/PHYSI/HPM/ENG/TZ0/XX

88066501

PHYSICS
HIGHER LEVEL
PAPER 1

Friday 3 November 2006 (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. Which **one** of the following quantities is a vector?

A. Work

B. Temperature

C. Electric field

D. Pressure

2. The volume of the Earth is approximately $10^{12}\,\text{km}^3$ and the volume of a grain of sand is approximately $1\,\text{mm}^3$. The order of magnitude of the number of grains of sand that can fit in the volume of the Earth is

A. 10^{12}.

B. 10^{18}.

C. 10^{24}.

D. 10^{30}.

3. The period T of oscillation of a mass m attached to the end of a spring is given by $T = 2\pi\sqrt{\frac{m}{k}}$, where k is an accurately known constant. The mass is measured as 0.500 ± 0.045 kg.

What is the percentage uncertainty in the calculated value of the period?

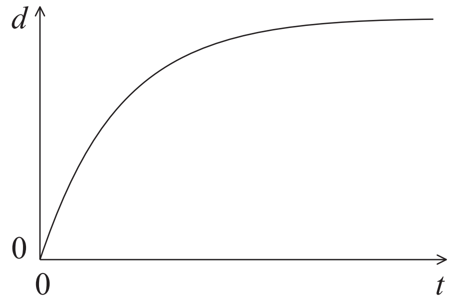
A. 3.0 %

B. 4.5 %

C. 9.0 %

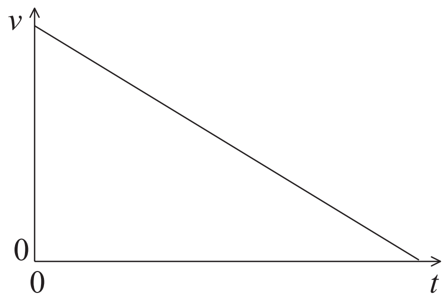
D. 18 %

4. The graph below shows the variation with time t of the displacement d of a body moving along a straight-line.

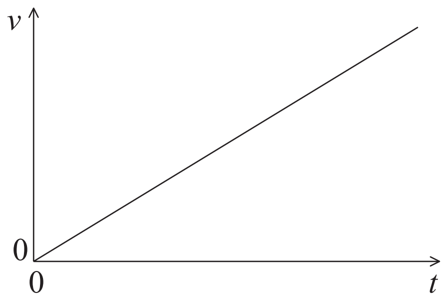


Which graph best represents the variation with time t of the velocity v of the body?

A.



B.



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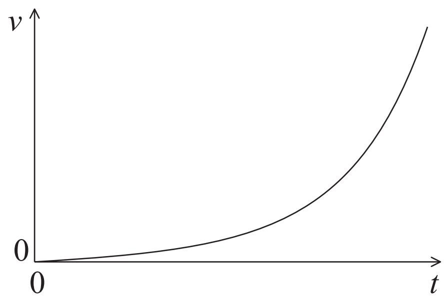

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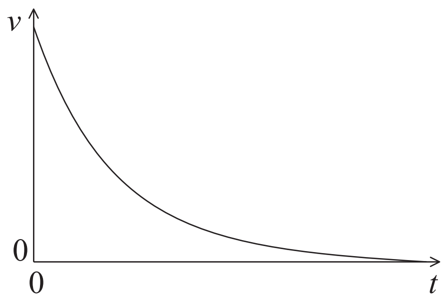


5. A body starting from rest moves along a straight-line under the action of a constant force. After travelling a distance d the speed of the body is v.

The speed of the body when it has travelled a distance $\frac{d}{2}$ from its initial position is

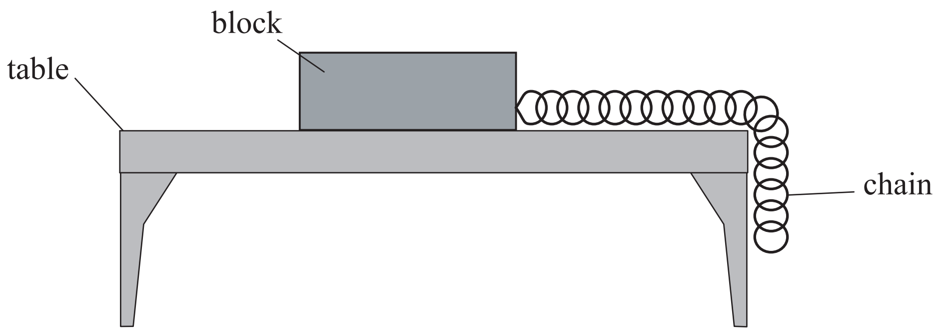
A. $\frac{v}{4}$.

B. $\frac{v}{2}$.

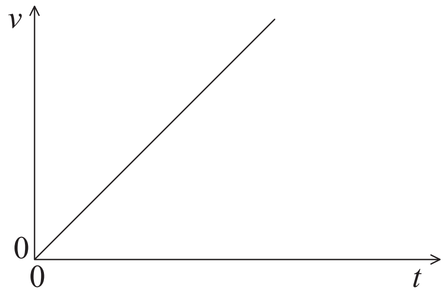
C. $\frac{v}{\sqrt{2}}$.

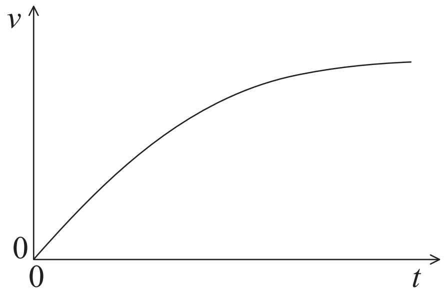
D. $\frac{v}{2\sqrt{2}}$.

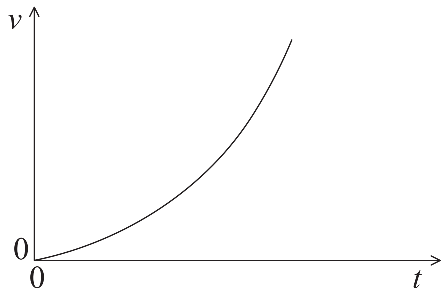
6. A block of mass *M* is held at rest on a horizontal table. A heavy chain is attached to the block with part of the chain hanging over the table. The block and the chain can slide without friction.



The block is released. Which **one** of the following graphs best represents the variation with time *t* of the speed *v* of the block as it moves on the table?

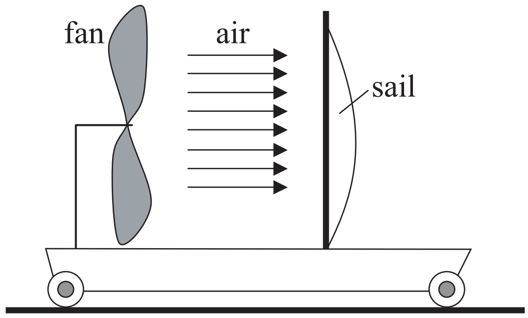
A.


B.


C.


D.


7. A fan and a sail are mounted vertically on a cart that is initially at rest on a horizontal table as shown in the diagram below.



When the fan is turned on an air stream is blown towards the right and is incident on the sail. The cart is free to move with negligible resistance forces.

After the fan has been turned on the cart will

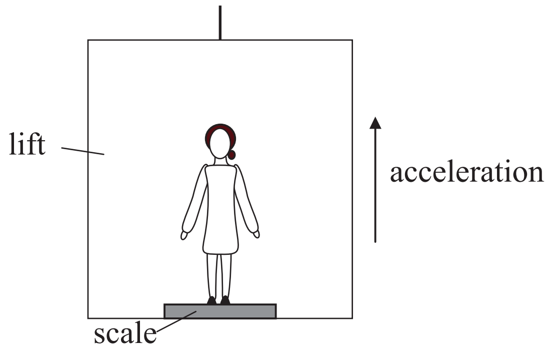
A. move to the left and then to the right.

B. remain at rest.

C. move towards the right.

D. move towards the left.

8. Mandy stands on a weighing scale inside a lift (elevator) that accelerates vertically upwards as shown in the diagram below. The forces on Mandy are her weight W and the reaction force from the scale R.



The reading of the scale is

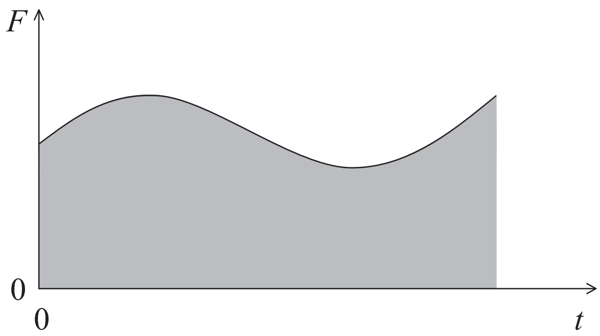
A. $R+W$.

B. W.

C. R.

D. $R-W$.

9. The graph below shows the variation with time t of the magnitude of the net force F acting on a body moving along a straight-line.



The shaded area represents

A. the total work done by F.

B. the change in the kinetic energy of the body.

C. the change in the momentum of the body.

D. the change in the velocity of the body.

10. A body moving along a straight-line has mass 3.0 kg and kinetic energy 24 J. The motion is then opposed by a net force of 4.0 N. The body will come to rest after travelling a distance of

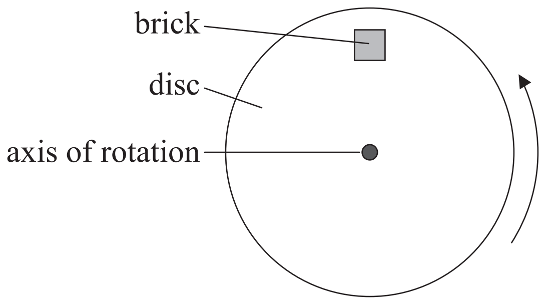
A. 2.0 m.

B. 6.0 m.

C. 8.0 m.

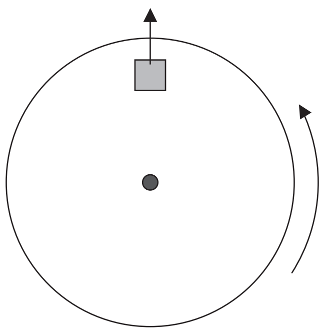
D. 12 m.

11. A brick is placed on the surface of a flat horizontal disc as shown in the diagram below. The disc is rotating at constant speed about a vertical axis through its centre. The brick does not move relative to the disc.

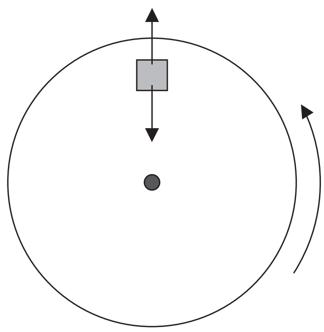


Which of the diagrams below correctly represents the **horizontal** force or forces acting on the brick?

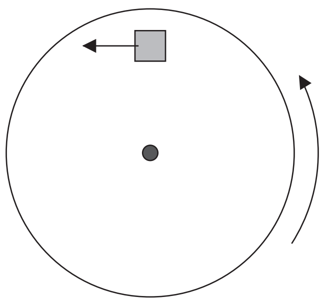
A.



B.



C.



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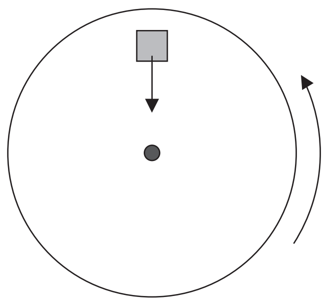
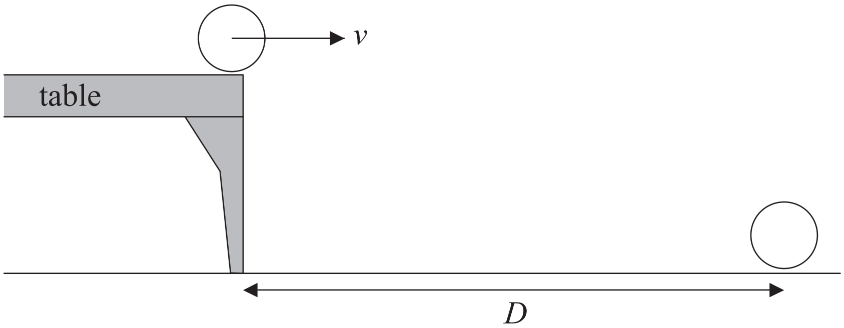


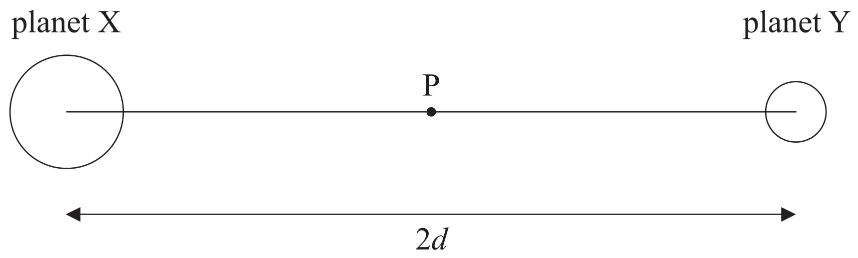
12. A ball rolls off a horizontal table with velocity v. It lands on the ground a time T later at a distance D from the foot of the table as shown in the diagram below. Air resistance is negligible.



A second **heavier** ball rolls off the table with velocity v. Which **one** of the following is correct for the heavier ball?

	Time to land	Distance from table
A.	T	D
B.	T	less than D
C.	less than T	D
D.	less than T	less than D

13. The diagram below shows two planets X and Y of masses $2M$ and M respectively. The centres of the two planets are separated by a distance $2d$. Point P is midway between planets X and Y. The mass of each planet may be assumed to be concentrated at its centre.



The magnitude of the gravitational field strength at point P due to the two planets is

A. zero.

B. $\frac{GM}{d^2}$.

C. $\frac{2GM}{d^2}$.

D. $\frac{3GM}{d^2}$.

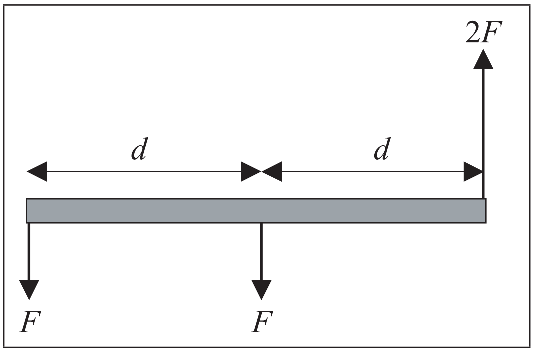
14. A satellite is in a circular orbit around the Earth. The satellite now moves to a circular orbit closer to the Earth.

Which **one** of the following correctly describes the changes in the gravitational potential energy and kinetic energy of the satellite?

	Gravitational potential energy	Kinetic energy
A.	decreases	decreases
B.	decreases	increases
C.	increases	decreases
D.	increases	increases

15. A rod on a horizontal table is acted upon by three horizontal forces. The magnitude and direction of the forces are indicated in the diagram below.

View of table from above



Which **one** of the following describes the state of equilibrium of the rod?

A. The rod is in translational and rotational equilibrium.

B. The rod is in translational equilibrium only.

C. The rod is in rotational equilibrium only.

D. The rod is neither in translational nor in rotational equilibrium.

16. Which **one** of the following correctly describes the changes, if any, of the kinetic energy and the potential energy of the molecules of a liquid as it is boiling?

	Kinetic energy	Potential energy
A.	increases	increases
B.	increases	stays constant
C.	stays constant	increases
D.	stays constant	stays constant

17. A fixed quantity of an ideal gas is compressed at constant temperature. The best explanation for the increase in pressure is that the molecules

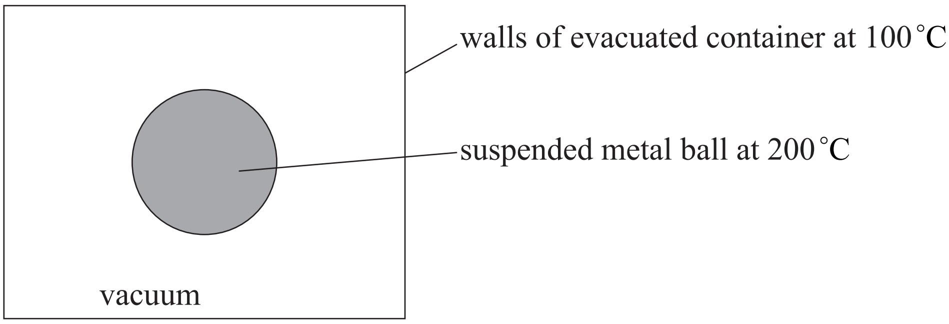
A. are moving faster.

B. are colliding more frequently with the container walls.

C. exert greater forces on each other.

D. are colliding more frequently with each other.

18. A metal ball at a temperature of 200 °C is suspended in an evacuated container. The walls of the container are kept at a **constant** temperature of 100 °C.



Which **one** of the following statements about the temperature of the ball is correct?

A. It will eventually reach absolute zero.

B. It will remain constant at 200 °C.

C. It will eventually become 100 °C.

D. It will eventually reach a constant temperature between 200 °C and 100 °C.

19. An ideal gas expands isothermally, doing 2500 J of external work in the process. The thermal energy absorbed by the gas in this process is

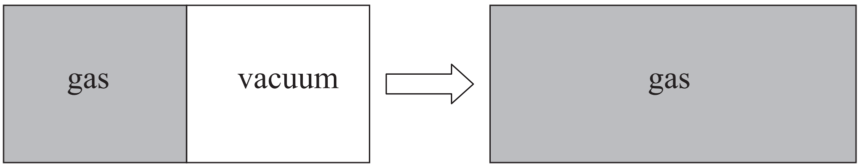
A. zero.

B. less than 2500 J.

C. equal to 2500 J.

D. more than 2500 J.

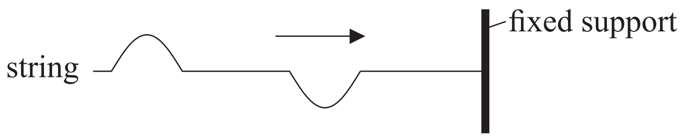
20. A well-insulated container is divided into two equal volumes by a wall. In one half there is an **ideal** gas and the other is a vacuum as shown below.



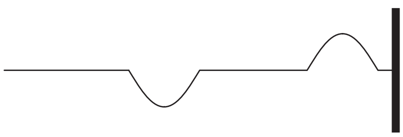
The wall is now removed. Which **one** of the following correctly gives the changes, if any, that take place in the internal energy and entropy of the gas?

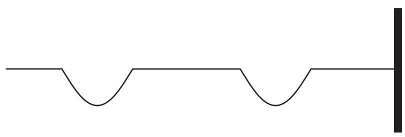
	Internal energy	**Entropy**
A.	stays the same	stays the same
B.	stays the same	increases
C.	decreases	stays the same
D.	decreases	increases

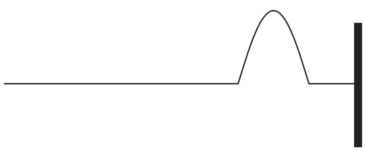
21. A string is held horizontally with one end attached to a fixed support. Two pulses are created at the free end of the string. The pulses are moving towards the fixed support as shown in the diagram below.

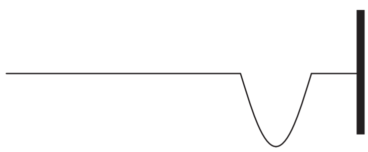


Which **one** of the following diagrams is a possible subsequent picture of the string?

A.


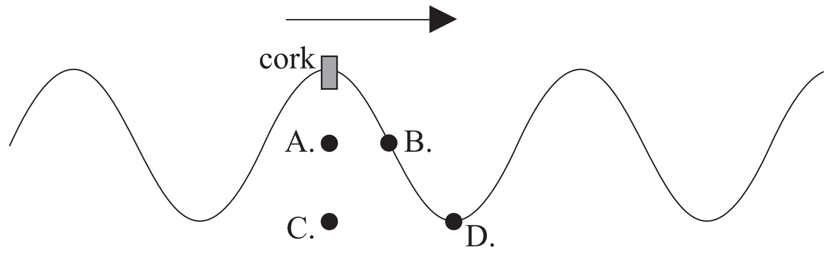
B.


C.


D.


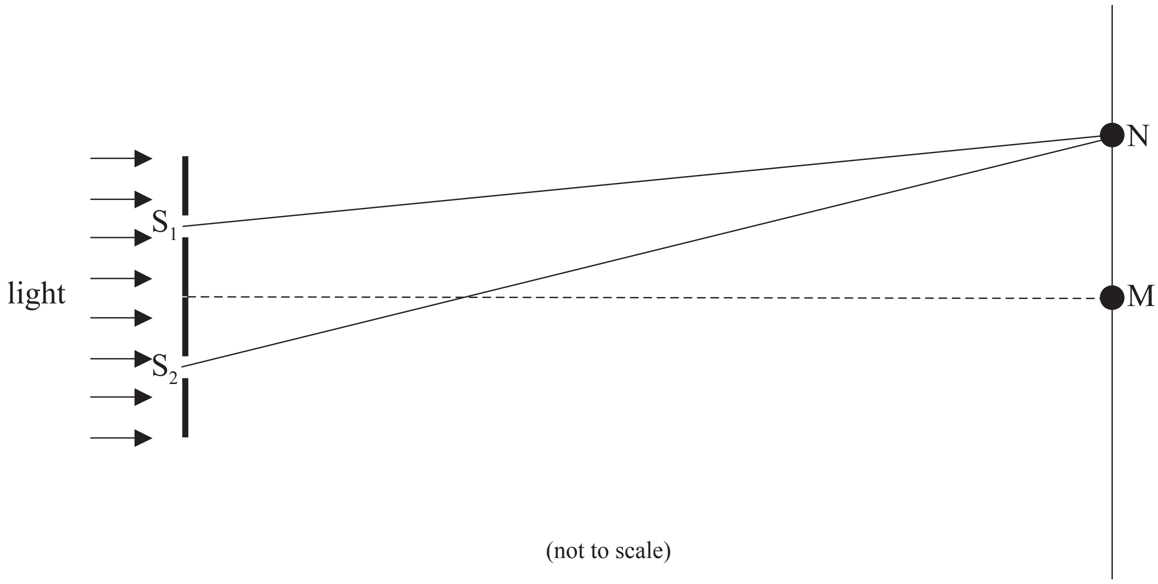
22. A water surface wave (ripple) is travelling to the right on the surface of a lake. The wave has period T. The diagram below shows the surface of the lake at a particular instant of time. A piece of cork is floating in the water in the position shown.

Which is the correct position of the cork a time $\frac{T}{4}$ later?



Questions 23 and 24 both refer to the following information and diagram.

The diagram below shows an arrangement for a two-slit interference experiment. Coherent light of frequency f is incident on two narrow parallel slits S_1 and S_2 and an interference pattern is observed on a screen a large distance away. The speed of light is c. The centre bright fringe is at M and the next bright fringe is at N.



23. The distance $S_2N - S_1N$ is equal to

A. $\dfrac{c}{2f}$.

B. $\dfrac{c}{f}$.

C. $\dfrac{f}{2c}$.

D. $\dfrac{f}{c}$.

24. Which **one** of the following changes would result in an increase of the fringe separation?

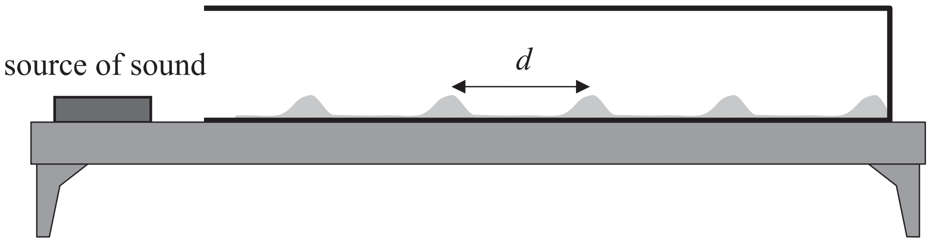
A. Decrease the frequency of the incident light.

B. Decrease the distance between the slits and the screen.

C. Increase the separation of the slits.

D. Increase the intensity of the incident light on the slits.

25. A source of sound is placed near the open end of a cylindrical tube that lies on a horizontal table. The tube has some powder sprinkled along its length. The powder collects in piles along the length of the tube as shown below.



The distance between two consecutive piles of powder is *d* and the speed of sound in the tube is *v*. The frequency of the source is

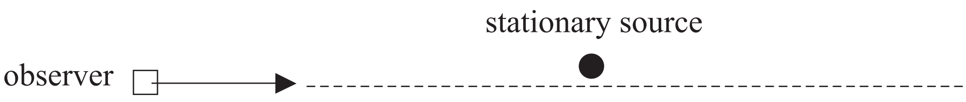
A. $\frac{v}{2d}$.

B. $\frac{v}{d}$.

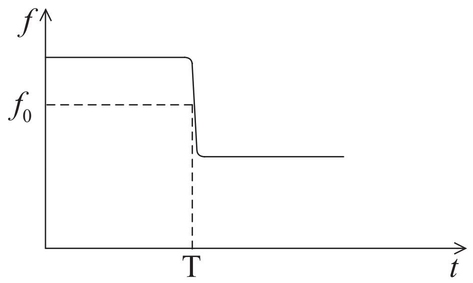
C. dv.

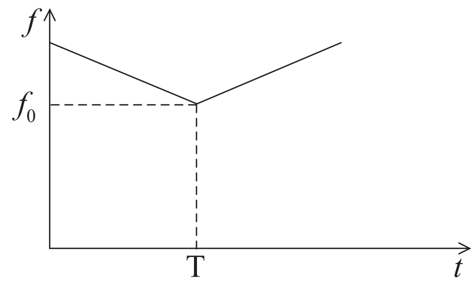
D. $2dv$.

26. A stationary source emits sound of frequency f_0. An observer is moving towards the source at constant speed along the path indicated by the dotted line. The observer passes very close to the source at time T.



Which **one** of the following graphs best shows the variation with time t of the frequency f heard by the observer?

A.


B.


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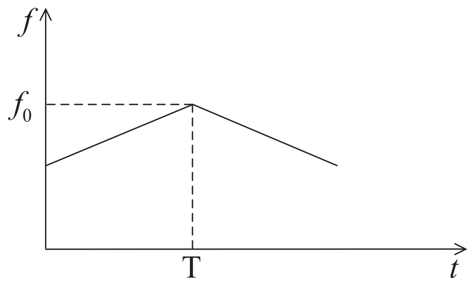

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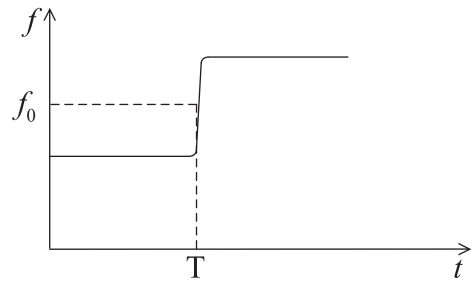
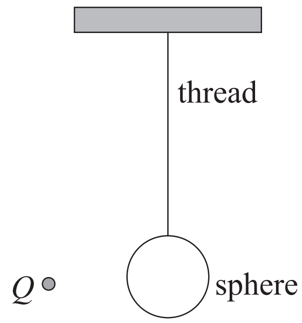


27. An electrically neutral conducting sphere is suspended vertically from an insulating thread.



A point charge of magnitude Q is brought near the sphere. The electric force between the point charge and the sphere

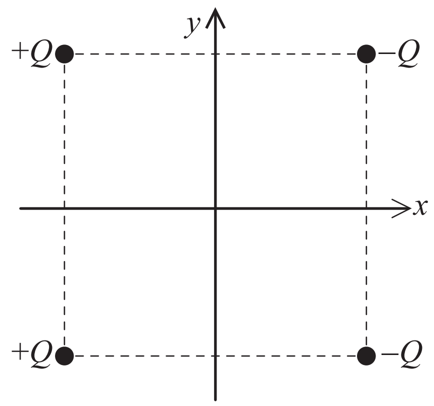
A. depends on whether Q is positive or negative.

B. is always zero.

C. is always repulsive.

D. is always attractive.

28. Four point charges of equal magnitude Q are placed at the corners of a square as shown below. The centre of the square is at the origin of the x-axis and the y-axis.



At which position, or positions, is the electric potential due to the four point charges equal to zero?

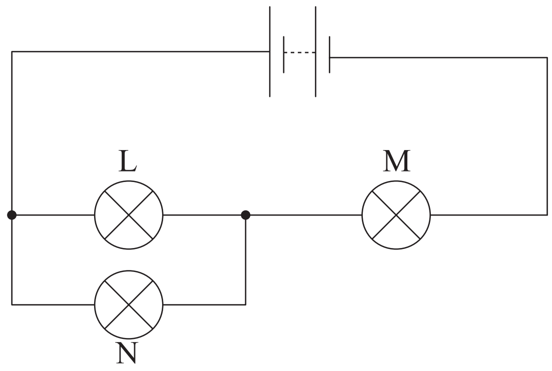
A. At the centre of the square only.

B. Along the x-axis only.

C. Along the y-axis only.

D. Along the x-axis and the y-axis.

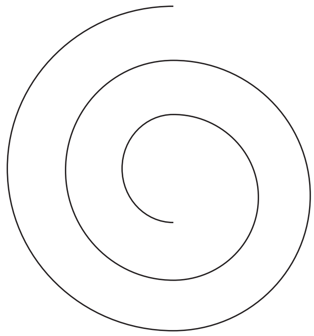
29. In the circuit below, the battery has negligible internal resistance. Three identical lamps L, M and N of constant resistance are connected as shown.



The filament of lamp N breaks. Which **one** of the following shows the subsequent changes to the brightness of lamp L and lamp M?

	Lamp L	Lamp M
A.	stays the same	decreases
B.	increases	stays the same
C.	increases	decreases
D.	decreases	increases

30. An electron is moving in air at right angles to a uniform magnetic field. The diagram below shows the path of the electron. The electron is slowing down.

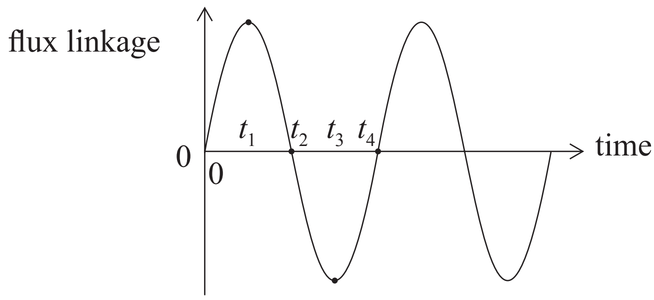


region of magnetic field

Which **one** of the following correctly gives the direction of motion of the electron and the direction of the magnetic field?

	Direction of motion	Direction of magnetic field
A.	clockwise	into plane of paper
B.	clockwise	out of plane of paper
C.	anti-clockwise	into plane of paper
D.	anti-clockwise	out of plane of paper

31. The diagram below shows the variation with time of the magnetic flux linkage through a coil.



At which times is the induced e.m.f. equal to zero?

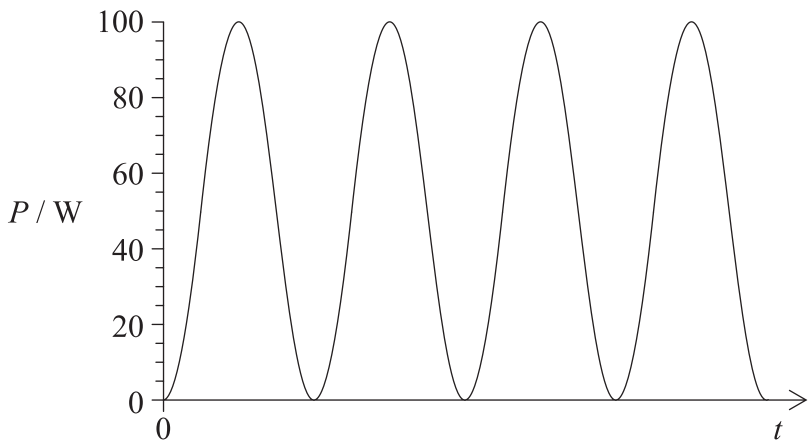
A. t_1 and t_3

B. t_2 and t_4

C. t_1 and t_2

D. t_1 and t_4

32. A lamp of resistance R is connected in series to a source of alternating voltage. The r.m.s. value of the voltage is 20 V. The variation with time t of the power P dissipated in the light bulb is shown below.



The best estimate for the value of the resistance of the filament of the lamp is

A. 4.0 Ω.

B. $4.0\sqrt{2}$ Ω.

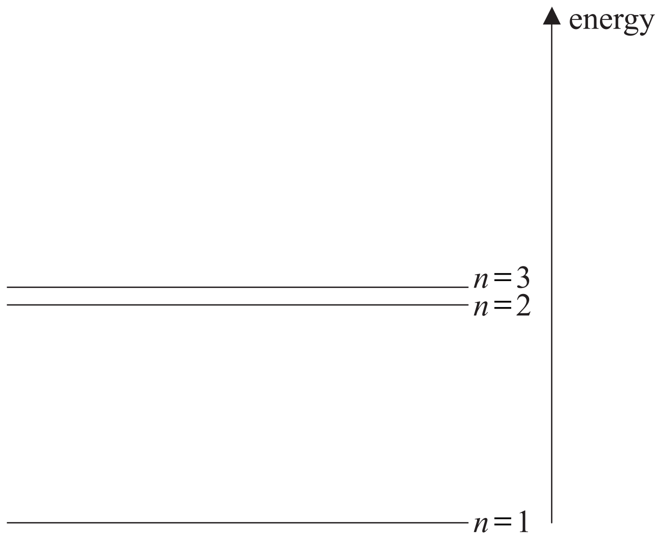
C. 8.0 Ω.

D. $8.0\sqrt{2}$ Ω.

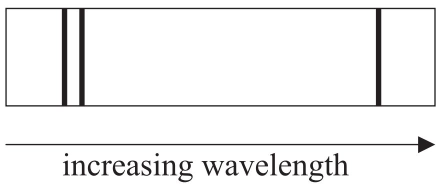
33. Which **one** of the following correctly identifies the mass and momentum of a photon?

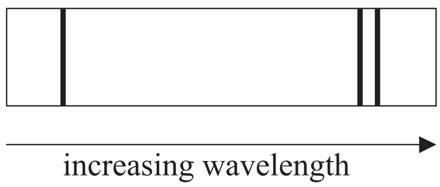
	Mass	**Momentum**
A.	zero	zero
B.	zero	non-zero
C.	non-zero	zero
D.	non-zero	non-zero

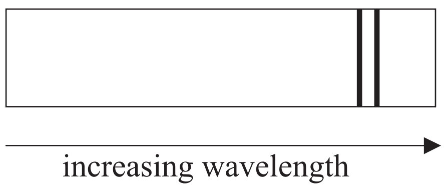
34. The diagram below shows the three lowest energy levels of an atom of an element.

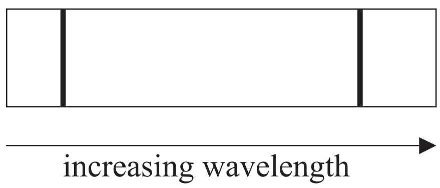


Which of the following diagrams best represents the emission spectrum that results from electron transitions between these energy levels?

A.


B.


C.


D.


35. According to the de Broglie hypothesis, matter waves are associated with

A. electrons only.

B. charged particles only.

C. neutral particles only.

D. all particles.

36. A radioactive isotope has a half-life of five minutes. A particular nucleus of this isotope has **not** decayed within a time interval of five minutes. A correct statement about the **next** five minute interval is that this nucleus

A. has a lower than 50 % chance of decaying.

B. will certainly decay.

C. has a 50 % chance of decaying.

D. has a better than 50 % chance of decaying.

37. The process represented by ${}^{3}_{2}\text{He} + {}^{3}_{2}\text{He} \rightarrow {}^{4}_{2}\text{He} + 2\,{}^{1}_{1}\text{H}$ would be described as

A. alpha decay.

B. nuclear fission.

C. nuclear fusion.

D. scattering of helium by helium.

38. A correct statement about nuclei is that most have approximately the same

A. radius.

B. density.

C. binding energy.

D. neutron to proton ratio.

39. The binding energy per nucleon of the nucleus ${}^{7}_{3}Li$ is approximately 5 MeV. The total energy required to completely separate the nucleons of this nucleus is approximately

A. 15 MeV.

B. 20 MeV.

C. 35 MeV.

D. 50 MeV.

40. Which **one** of the following is an exchange particle?

A. Lepton

B. Neutrino

C. Quark

D. Photon