



**PHYSICS  
HIGHER LEVEL  
PAPER 1**

Wednesday 2 May 2007 (afternoon)

1 hour

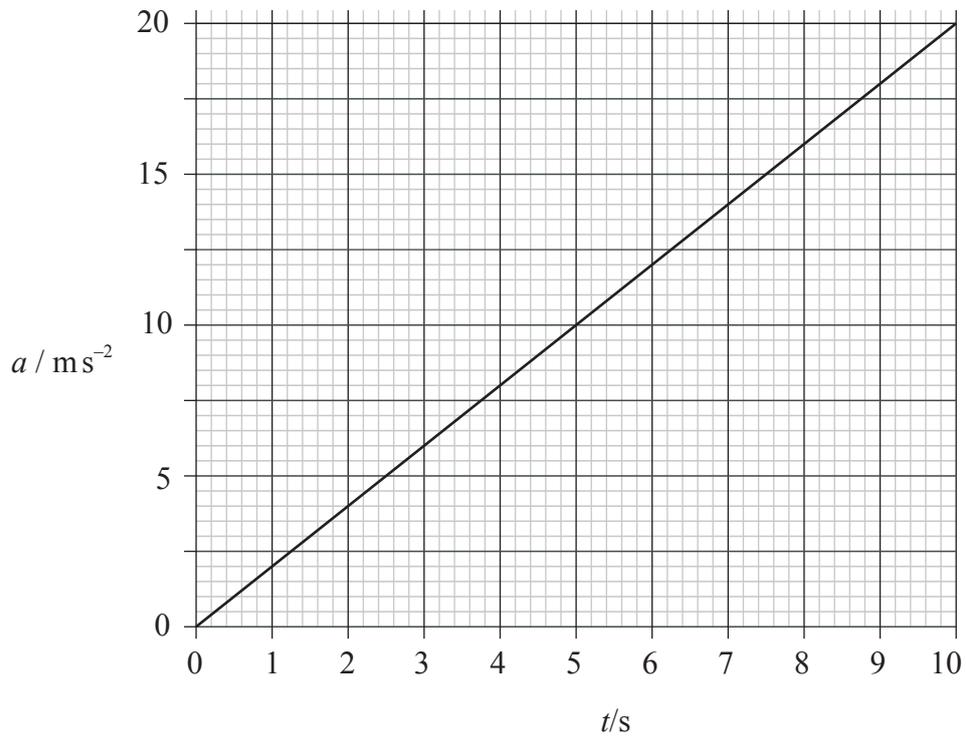
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**INSTRUCTIONS TO CANDIDATES**

- 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.

1. The time interval between human heartbeats is of the order of
  - A.  $10^{-2}$  s.
  - B.  $10^{-1}$  s.
  - C.  $10^0$  s.
  - D.  $10^1$  s.
  
2. The kilowatt-hour is equivalent to approximately
  - A. 60 J.
  - B.  $3.6 \times 10^3$  J.
  - C.  $8.6 \times 10^4$  J.
  - D.  $3.6 \times 10^6$  J.
  
3. The sides of a cube are each of length 1.00 m. Each side is measured with an uncertainty of 2%. The absolute uncertainty in the volume of the cube is
  - A.  $\pm 0.02$  m<sup>3</sup>.
  - B.  $\pm 0.06$  m<sup>3</sup>.
  - C.  $\pm 0.2$  m<sup>3</sup>.
  - D.  $\pm 0.6$  m<sup>3</sup>.

4. The graph shows the variation with time  $t$  of the acceleration  $a$  of an object.



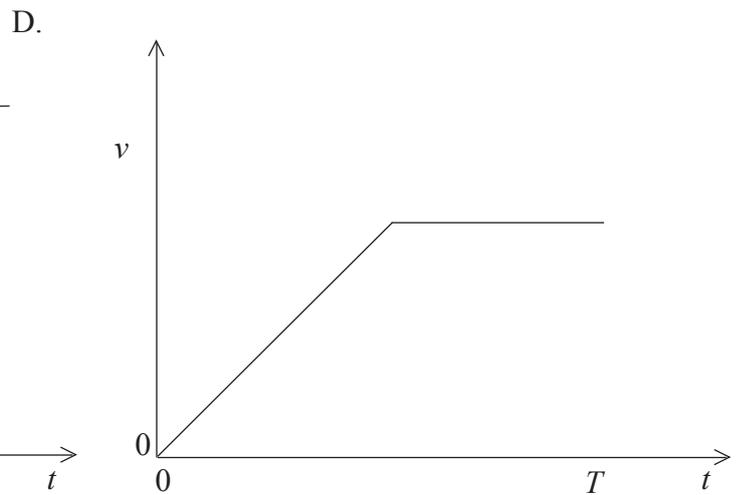
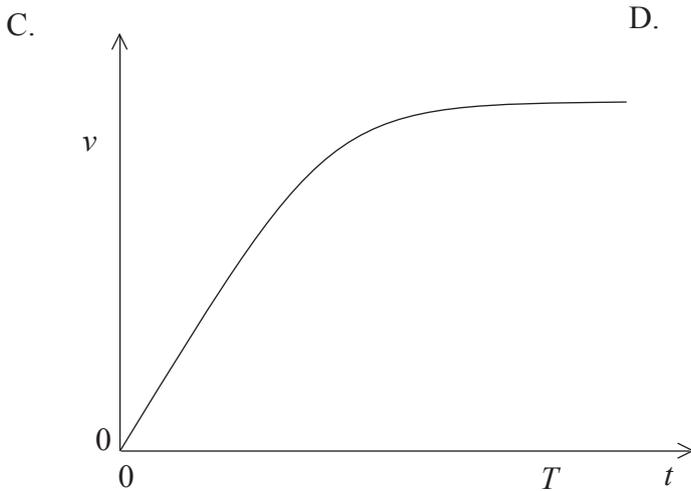
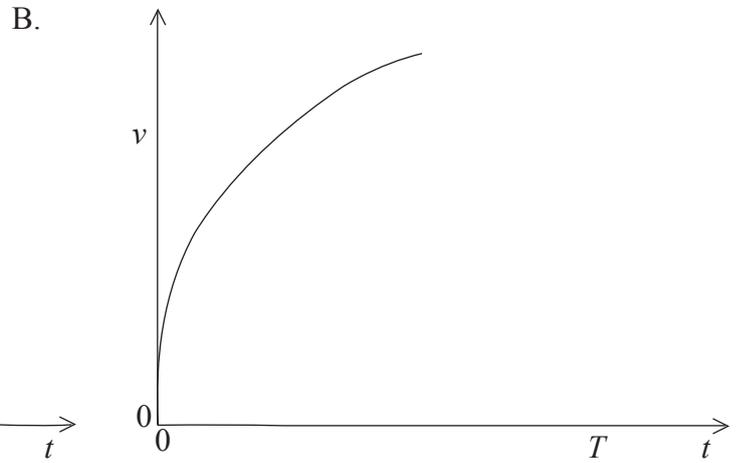
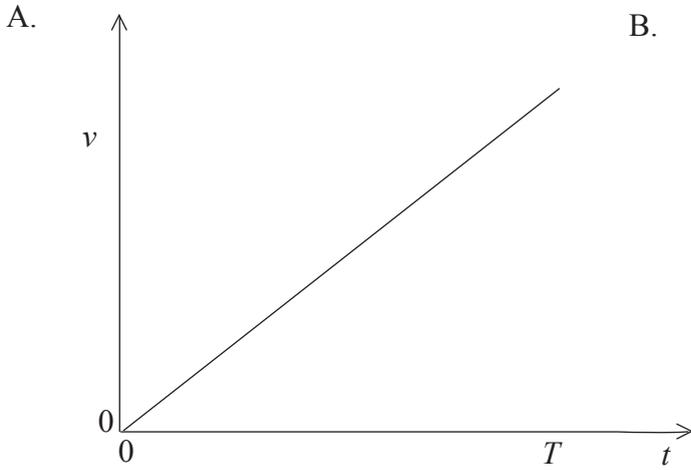
The object is at rest at time  $t = 0$ .

Which of the following is the velocity of the object at time  $t = 6.0$  s?

- A.  $0.50 \text{ ms}^{-1}$
- B.  $2.0 \text{ ms}^{-1}$
- C.  $36 \text{ ms}^{-1}$
- D.  $72 \text{ ms}^{-1}$

5. An object is dropped from rest from a point several hundred metres above the surface of the Earth at time  $t = 0$ . The object strikes the ground at  $t = T$  and air resistance is **not** negligible.

Which of the following sketch graphs best shows the variation with time  $t$ , of the speed  $v$  of the object?



6. Which of the following is a correct definition of average acceleration?

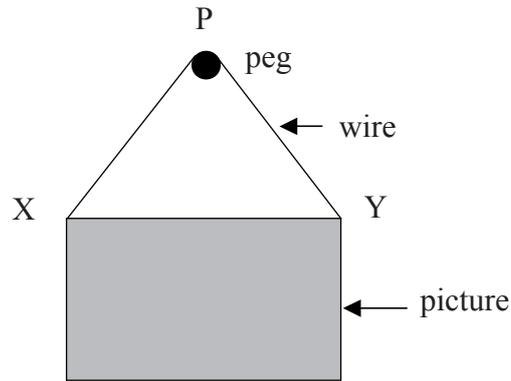
A.  $\frac{\text{change in velocity}}{\text{time taken}}$

B.  $\frac{\text{velocity}}{\text{time taken}}$

C.  $\frac{\text{change in speed}}{\text{time taken}}$

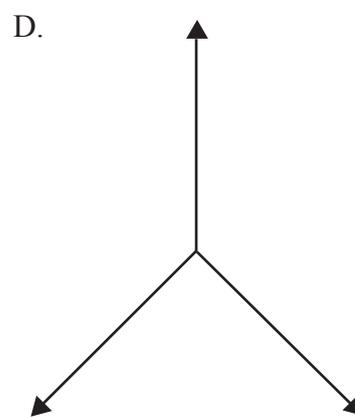
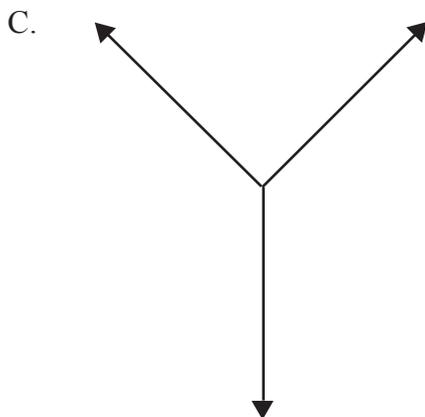
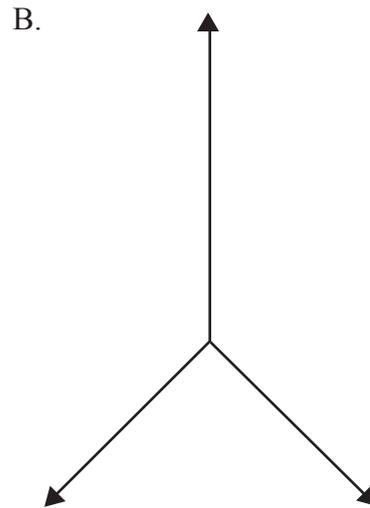
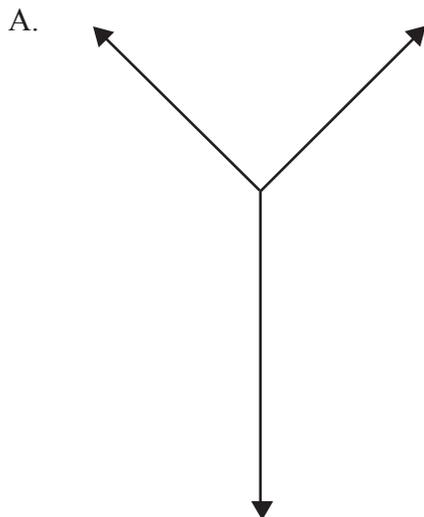
D.  $\frac{\text{speed}}{\text{time taken}}$

7. A picture is supported vertically by a wire that is looped over a horizontal light peg P. There is no friction between the wire and the peg.



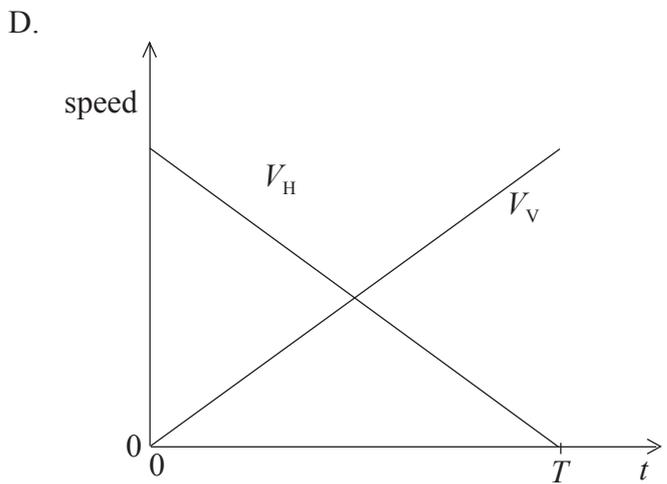
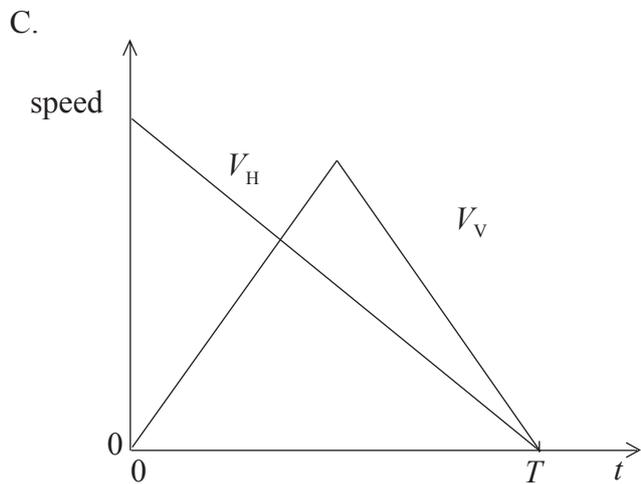
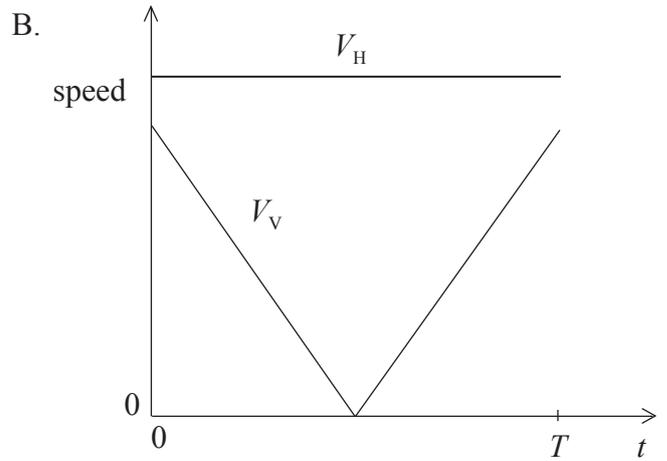
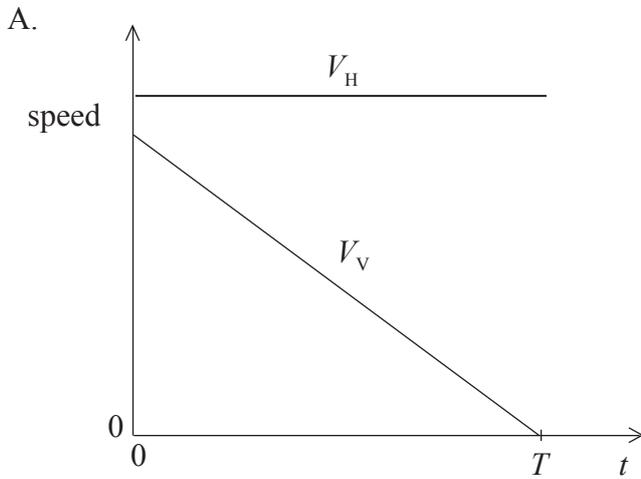
The mass of the picture is uniformly distributed and  $PX = PY$ .

Which of the following best represents the free body diagram of the forces acting on the peg?



8. All objects at any particular point on the Earth's surface have the same value of free fall acceleration. The reason for this is because the magnitude of the
- A. gravitational force acting on each object is the same.
  - B. gravitational and inertial mass of each object is the same.
  - C. gravitational force acting on any object is proportional only to its gravitational mass.
  - D. gravitational force acting on any object is proportional only to its inertial mass.
9. A net force of magnitude  $F$  acts on a body for a time  $\Delta t$  producing an impulse of magnitude  $Y$ . Which of the following is the magnitude of the rate of change of momentum of the body?
- A.  $F$
  - B.  $F\Delta t$
  - C.  $Y$
  - D.  $Y\Delta t$
10. A machine lifts an object of weight  $W$  at constant speed through a vertical distance  $h$ . The efficiency of the machine is 25%. The total input energy to the machine is
- A.  $0.25Wh$ .
  - B.  $0.75Wh$ .
  - C.  $2.5Wh$ .
  - D.  $4.0Wh$ .

11. A projectile is fired from the ground at time  $t = 0$ . It lands back on the ground at time  $t = T$ . Which of the following sketch graphs best shows the variation with time  $t$  of the vertical speed  $V_v$  and horizontal speed  $V_H$  of the projectile? Air resistance is negligible.



12. The magnitude of the gravitational field strength at the surface of a planet of radius  $R$  is  $8.0 \text{ N kg}^{-1}$ . Which of the following is a correct expression for the gravitational potential at the surface of the planet?

A.  $-\frac{8.0}{R}$

B.  $-\frac{8.0}{R^2}$

C.  $-\frac{R}{8.0}$

D.  $-8.0R$

13. A satellite is in an orbit around the Earth. It is moved to a new orbit that is closer to the surface of the Earth. Which of the following correctly describes the changes in the gravitational potential energy and in the orbital speed of the satellite?

	<b>potential energy</b>	<b>speed</b>
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

14. Two satellites X and Y are in orbit around the Earth. The orbital radius of satellite X is twice that of satellite Y.

Which of the following correctly gives the ratio

$$\frac{\text{orbital period of X}}{\text{orbital period of Y}} \text{ ?}$$

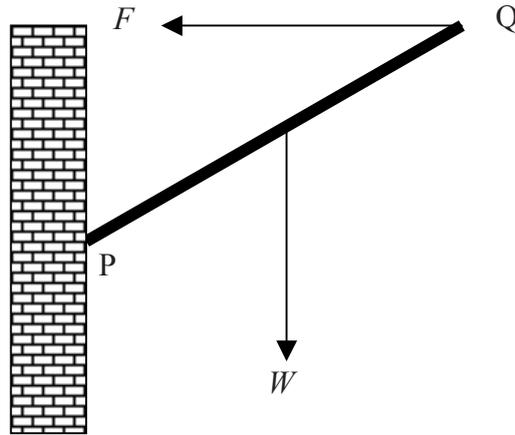
- A.  $2\sqrt{2}$
- B.  $\sqrt[3]{4}$
- C.  $\frac{1}{2\sqrt{2}}$
- D.  $\frac{1}{\sqrt[3]{4}}$

15. A block is at rest on a horizontal surface. The magnitude of the minimum force to start the block moving is  $F_M$ . The magnitude of the force required to keep the block moving at constant speed is  $F_C$ .

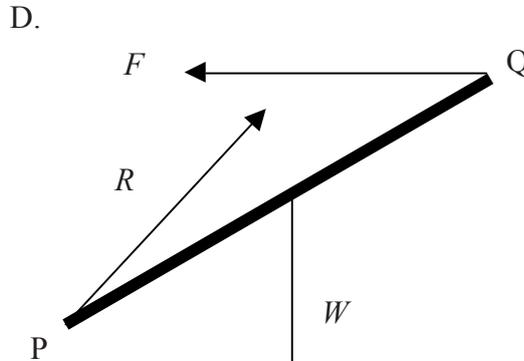
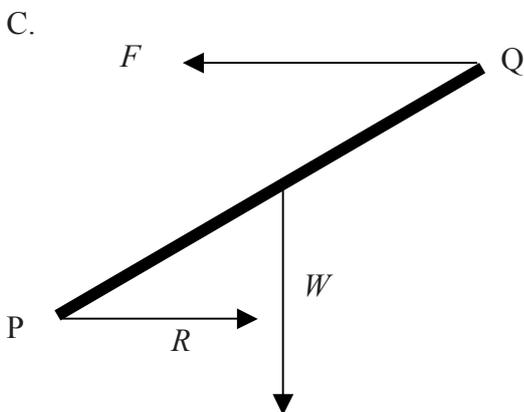
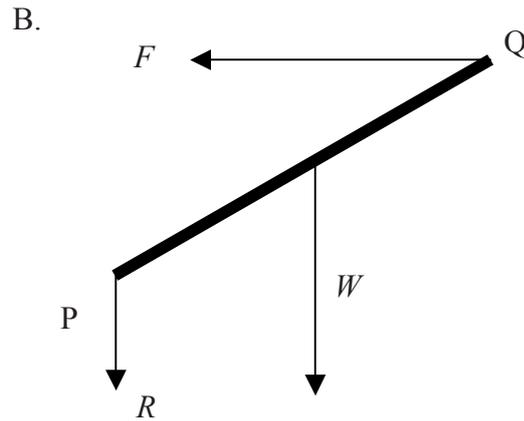
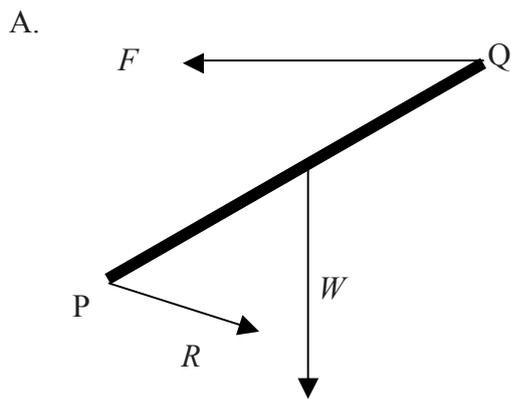
Which of the following statements is true?

- A.  $F_M$  will always equal  $F_C$  provided the speed of the block is not too great.
- B.  $F_M$  will always be equal to  $F_C$  no matter what the speed of the block.
- C.  $F_M$  will always be greater than  $F_C$ .
- D.  $F_M$  will always be less than  $F_C$ .

16. A uniform rod PQ of weight  $W$  is attached to a vertical wall at end P by a hinge. A force of magnitude  $F$  acts on the rod at end Q as shown such that the rod is in equilibrium.



Which of the following diagrams best shows the correct direction of the reaction force  $R$  at the hinge?

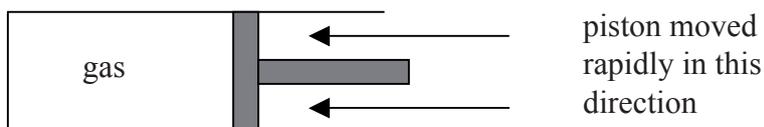


17. Two objects X and Y are made of the same material. Object X is more massive than object Y. Both objects are at the same temperature.

Which of the following correctly compares the average kinetic energy and also the total energy of the molecules in the objects?

	average kinetic energy of the molecules in X and Y	total energy of the molecules in X and Y
A.	same	greater in X than in Y
B.	same	less in X than in Y
C.	greater in X than in Y	same
D.	less in X than in Y	same

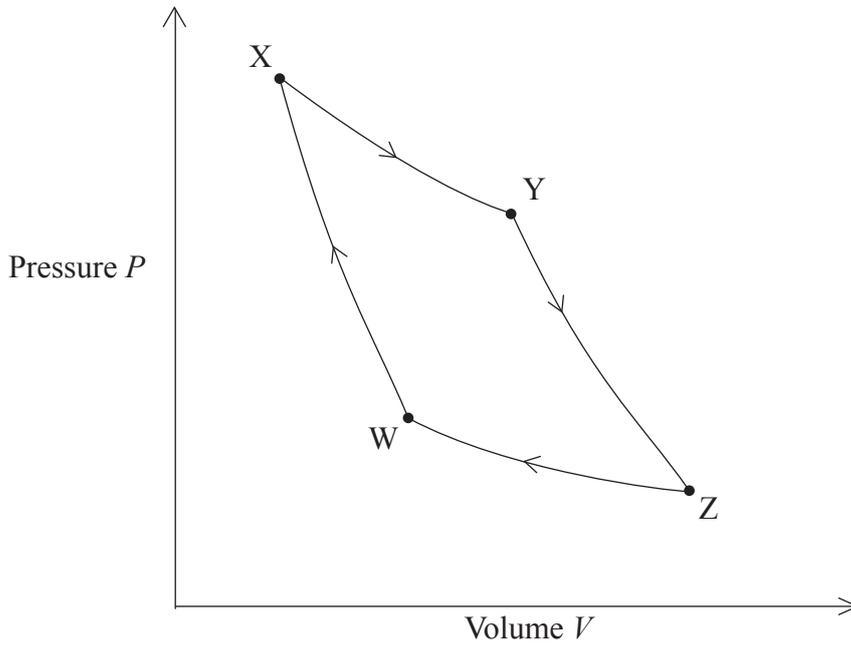
18. An ideal gas is contained in a cylinder by a piston. The volume of the gas is decreased by moving the piston rapidly in the direction shown.



The average speed of the gas molecules is initially increased because the molecules

- A. have a smaller volume in which to move.
- B. make more collisions in unit time with the cylinder walls and piston.
- C. have energy transferred to them as they collide with the moving piston.
- D. make more collisions with each other in unit time.

19. The diagram shows the relation between the pressure  $P$  and the volume  $V$  of an ideal gas in a Carnot engine during one cycle of operation of the engine.

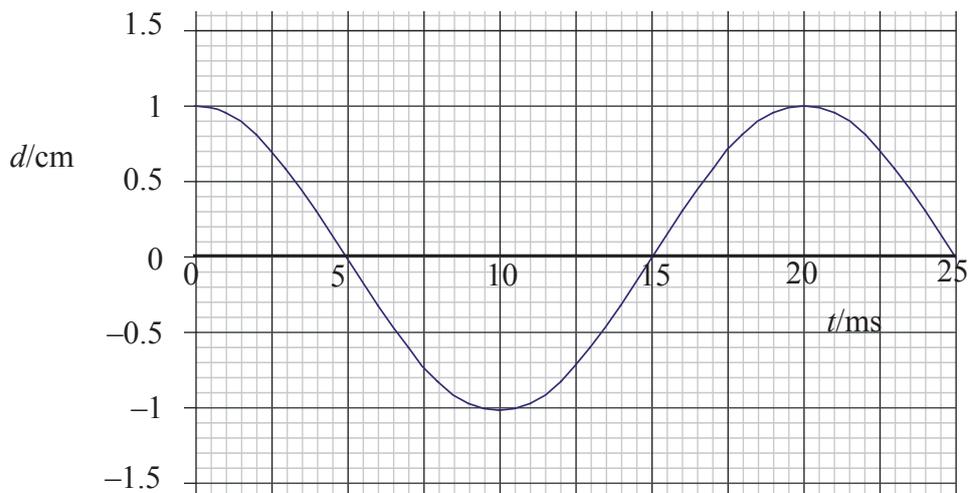


In which part of the cycle is thermal energy transferred from the gas to the surroundings?

- A. XY
  - B. YZ
  - C. ZW
  - D. WX
20. A beaker contains water at a higher temperature than its surroundings. Which of the following correctly describes the entropy change in the water and in the surroundings as the water cools?

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

21. A wave is travelling through a medium. The diagram shows the variation with time  $t$  of the displacement  $d$  of a particle of the medium from  $t = 0$  to  $t = 25$  ms.



Which of the following correctly gives the frequency and the amplitude of the wave?

	<b>frequency / Hz</b>	<b>amplitude / cm</b>
A.	$2.0 \times 10^{-2}$	2.0
B.	$2.0 \times 10^{-2}$	1.0
C.	50	2.0
D.	50	1.0

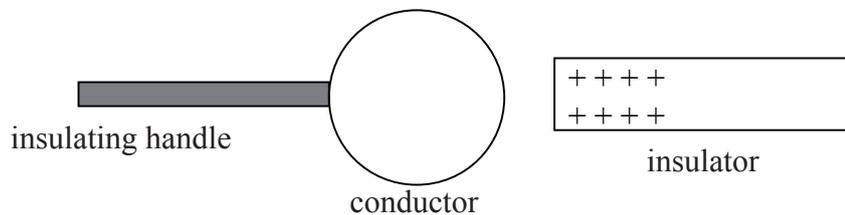
22. Waves of frequency  $f$  travel with speed  $c$  in air and enter a medium M of refractive index 1.5. Which of the following correctly gives the frequency and speed of the waves in the medium M?

	frequency	speed
A.	$f$	$\frac{c}{1.5}$
B.	$f$	$1.5c$
C.	$1.5f$	$c$
D.	$\frac{f}{1.5}$	$c$

23. A police car, sounding its siren, is travelling at constant speed towards a stationary observer. The sound emitted by the siren is of constant frequency. The frequency of the sound as heard by the observer is higher than that heard by the driver of the police car. The reason for this is that
- A. the wavefronts received by the observer are closer together than the wavefronts received by the driver.
  - B. the speed of the wavefronts is greater as measured by the observer than by the driver.
  - C. the speed of the wavefronts is less as measured by the observer than by the driver.
  - D. the wavefronts received by the observer are further apart than the wavefronts received by the driver.
24. The light waves emitted by two coherent sources overlap and form an observable interference pattern. The word coherent in this situation means that
- A. the sources are point sources.
  - B. there is a constant phase difference between the light waves emitted by the sources.
  - C. the sources emit light of the same frequency.
  - D. the sources emit light of the same amplitude.

25. A piano tuner tunes a particular piano string by playing the note emitted by the string. At the same time he sounds a tuning fork of known frequency. He listens to the sound formed between this note and the note emitted by the piano string. The piano tuner will know that the frequency emitted by the two notes is nearly the same when
- A. the beat frequency is very small.
  - B. the beat frequency is very large.
  - C. there is a sharp increase in loudness.
  - D. there is a sharp decrease in loudness.

26. An isolated, uncharged metal conductor is brought close to a positively charged insulator.

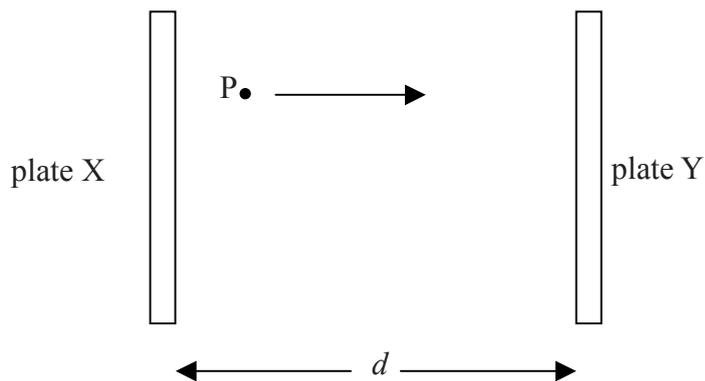


The conductor is earthed for a short time and then the insulator is removed.

Which of the following best represents the charge distribution on the surface of the conductor as a result of these actions?

- A. A circle with eight '-' signs distributed on the left side.
- B. A circle with eight '-' signs distributed on the right side.
- C. A circle with eight '+' signs distributed on the left side.
- D. A circle with eight '+' signs distributed on the right side.

27. A charged particle P is accelerated between two charged metal plates X and Y separated by a distance  $d$ . The particle starts from rest at plate X.



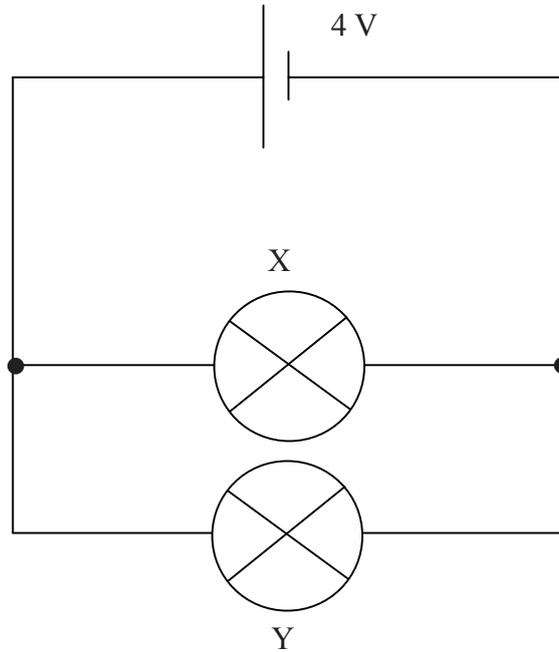
The kinetic energy of P, when it reaches plate Y, is  $K$ . The magnitude of the charge on P is  $e$ .

The magnitude of the electric field strength between the plates is

- A.  $\frac{de}{K}$ .
- B.  $\frac{d}{Ke}$ .
- C.  $\frac{K}{ed}$ .
- D.  $\frac{Ke}{d}$ .
28. Which of the following is a correct statement of Ohm's law?
- A. The resistance of a conductor is always constant.
- B. The current in a conductor is always proportional to the potential difference across the conductor.
- C. The resistance of a conductor increases with increasing temperature.
- D. The resistance of a conductor is constant only if the temperature of the conductor is constant.

29. Two filament lamps X and Y are designed to operate at normal brightness when the potential difference across the lamps is 6 V. Each lamp will just light when the potential difference across it is 3 V.

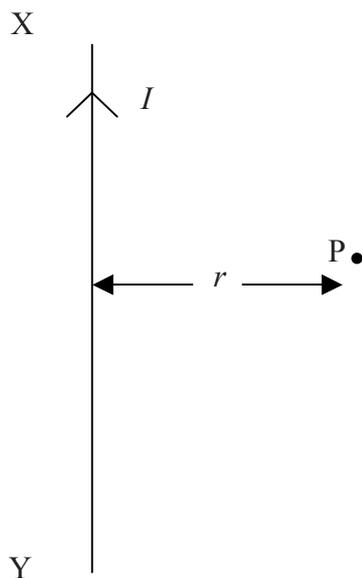
The two lamps are connected in parallel to a 4 V supply of negligible internal resistance as shown below.



The filament of lamp X breaks so that there is no current in it. The filament of lamp Y will

- A. glow at normal brightness.
- B. glow at more than normal brightness.
- C. glow more dimly.
- D. stay at the same brightness.

30. The diagram shows part of a long, straight vertical wire in which there is a current  $I$ . P is a charged particle at a distance  $r$  from the wire. The magnitude of the charge of P is  $q$ .



The particle P is moving normally into the plane of the paper with speed  $v$ . The magnitude of the force on P due to the magnetic field of the wire is

- A. zero.
- B.  $\frac{\mu_0 I}{2\pi r} qv$ .
- C.  $\frac{\mu_0 Iq}{2\pi r v}$ .
- D.  $\frac{\mu_0 I v}{2\pi r q}$ .

31. X and Y are two points in an electric field. The potentials at X and Y are  $V_X$  and  $V_Y$  respectively where  $V_X > V_Y$ . A small, positive test charge  $+q$  is placed at X.

Which of the following is the work done per unit charge **by** the electric field on the charge as the charge moves from point X to point Y?

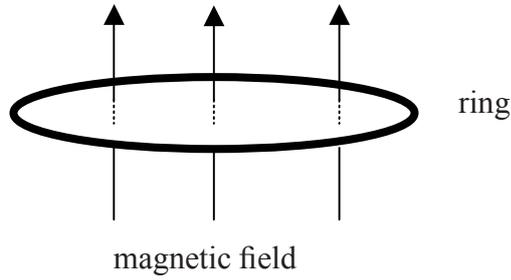
A.  $-(V_X - V_Y)$

B.  $+(V_X - V_Y)$

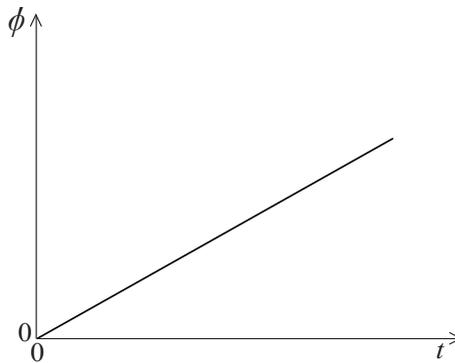
C.  $\frac{-(V_X - V_Y)}{q}$

D.  $\frac{+(V_X - V_Y)}{q}$

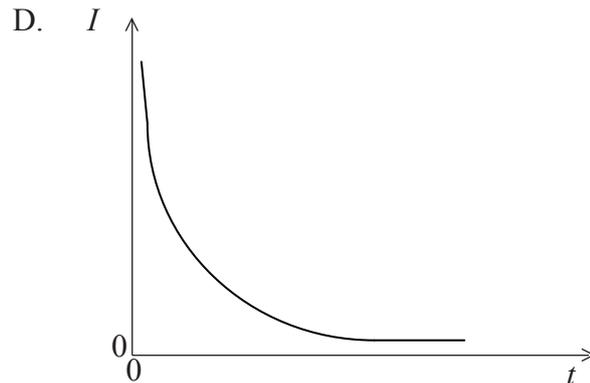
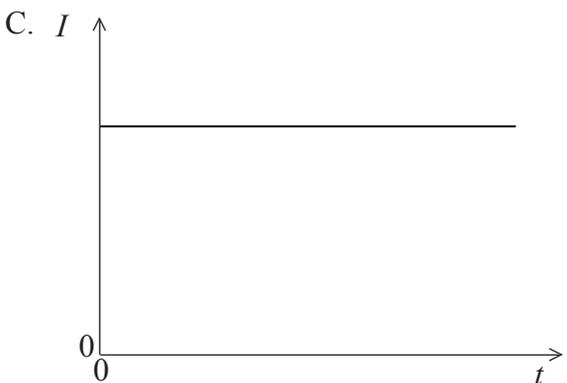
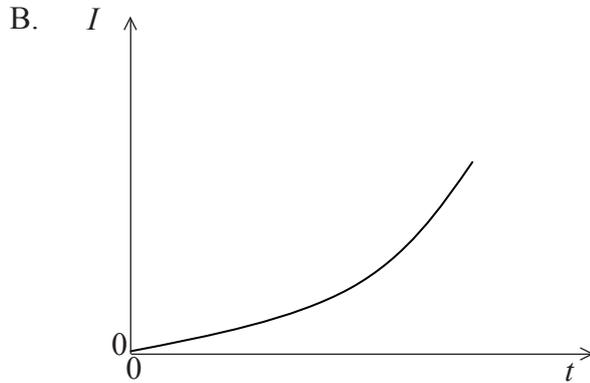
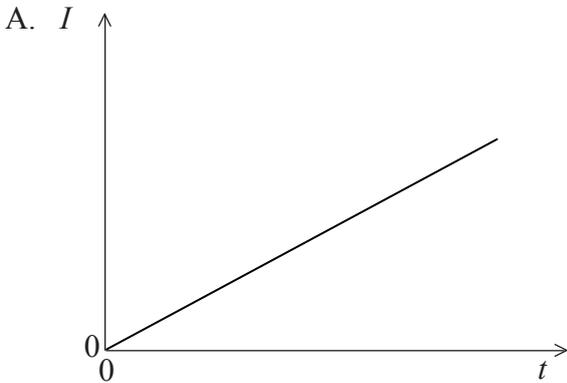
32. A metal ring is placed in a region of uniform magnetic field such that the plane of the ring is perpendicular to the direction of the field. The field strength is increasing at a constant rate.



The sketch-graph shows the variation with time  $t$  of the magnetic flux  $\phi$  linking the ring.



Which of the following graphs best shows the variation with time  $t$  of the induced current  $I$  in the ring?



33. A resistor of resistance  $R$  is connected in series with a sinusoidal alternating supply having a maximum value of e.m.f.  $V_0$ .

The best estimate for the average power dissipated in the resistor during one cycle of the alternating current is

- A.  $\frac{2V_0^2}{R}$ .
- B.  $\sqrt{2} \frac{V_0^2}{R}$ .
- C.  $\frac{V_0^2}{\sqrt{2}R}$ .
- D.  $\frac{V_0^2}{2R}$ .

34. The atomic line spectra of elements provides evidence for the existence of

- A. photons.
- B. electrons.
- C. quantized energy states within nuclei.
- D. quantized energy states within atoms.

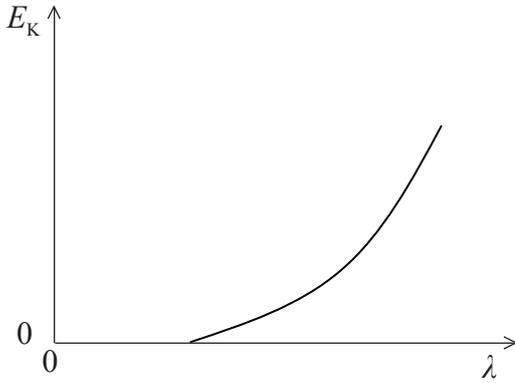
35. A nucleus of uranium  $-233$  ( ${}^{233}_{92}\text{U}$ ) undergoes  $\alpha$ -decay. Which of the following correctly identifies the number of protons  $Z$  and the number of neutrons  $N$  of the nucleus produced by this decay?

	$Z$	$N$
A.	90	229
B.	90	139
C.	88	231
D.	88	141

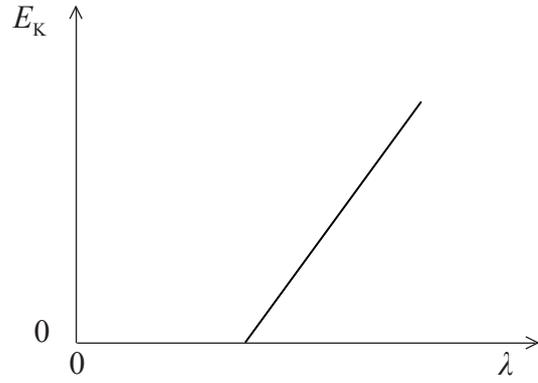
36. Light of wavelength  $\lambda$  is incident on a metal surface in a vacuum. Photoelectrons are emitted from the surface of the metal.

Which of the following best shows the variation with  $\lambda$  of the maximum kinetic energy  $E_K$  of the emitted electrons?

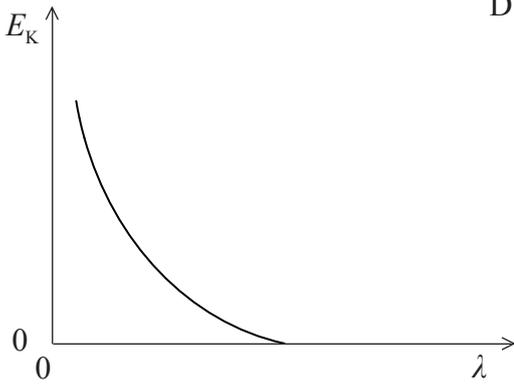
A.



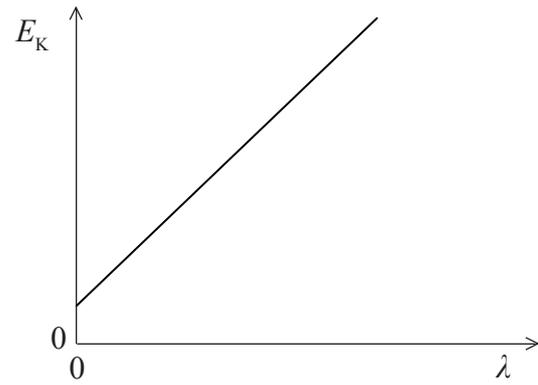
B.



C.

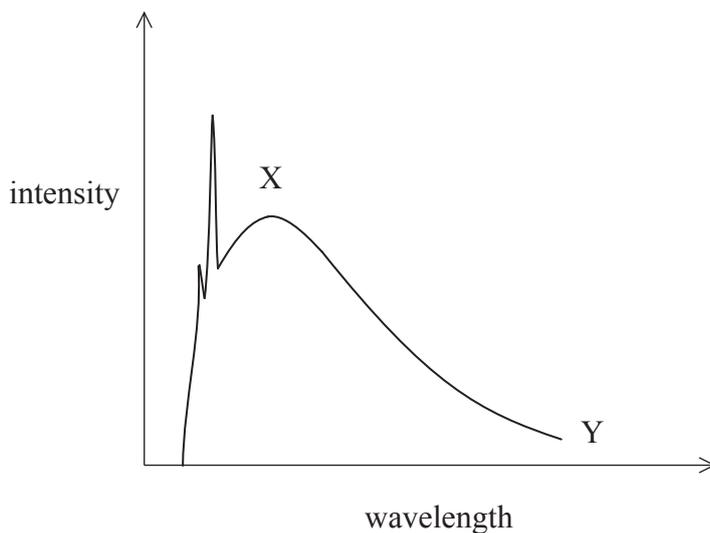


D.



37. The de Broglie wavelength associated with a car moving with a speed of  $20 \text{ ms}^{-1}$  is of the order of
- A.  $10^{-38} \text{ m}$ .
  - B.  $10^{-4} \text{ m}$ .
  - C.  $10^4 \text{ m}$ .
  - D.  $10^{38} \text{ m}$ .

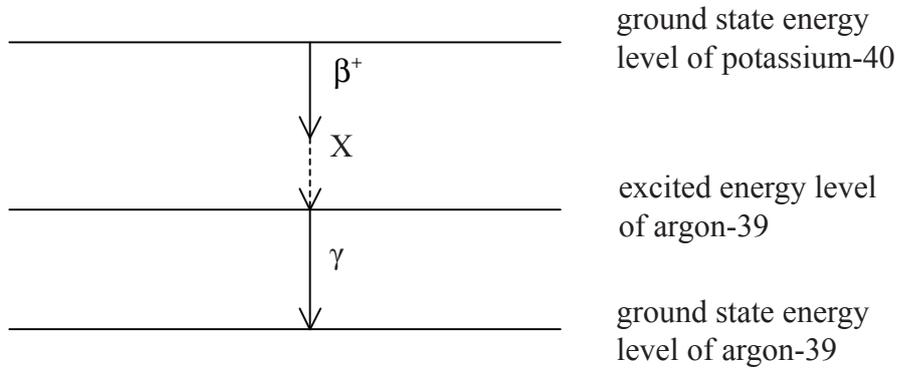
38. The diagram shows a typical X-ray spectrum produced by the bombardment of a heavy metal target by high energy electrons.



Which of the following best explains the part of the spectrum labelled XY?

- A. The diffraction of the electrons striking the metal target
- B. The rise in temperature of the metal target
- C. The acceleration of the electrons striking the metal target
- D. Electron transitions between energy levels in the atoms of the metal target

39. A nucleus of potassium-40 undergoes  $\beta^+$  decay to an excited state of a nucleus of argon-39. The argon-39 then reaches its ground state by the emission of a  $\gamma$ -ray photon. The diagram represents the  $\beta^+$  and  $\gamma$  energy level diagram for this decay process.



The particle represented by the letter X is

- A. an antineutrino.
  - B. a neutrino.
  - C. an electron.
  - D. a photon.
40. The type of exchange particle associated with the weak interaction is a
- A. pion.
  - B. gluon.
  - C. photon.
  - D. boson.
-