

**PHYSICS
HIGHER LEVEL
PAPER 1**

Thursday 17 November 2005 (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. The mass of an atom of the isotope strontium-92 (^{92}Sr) is of the order of
- A. 10^{-23} kg.
 - B. 10^{-25} kg.
 - C. 10^{-27} kg.
 - D. 10^{-29} kg.

2. Which **one** of the following is a fundamental unit in the SI system?
- A. Ampere
 - B. Volt
 - C. Ohm
 - D. Tesla

3. The relationship between two measured quantities P and Q is of the form

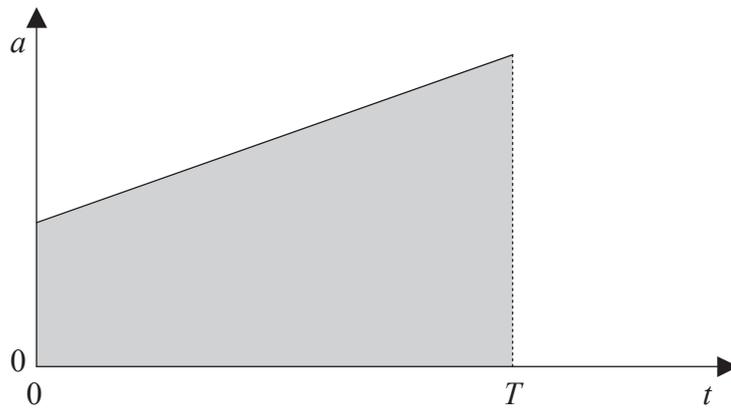
$$P = kQ^n$$

where k and n are constants.

A plot of $\lg P$ (y -axis) against $\lg Q$ (x -axis) will enable the value of k to be determined by measuring only

- A. the intercept on the $\lg P$ axis.
- B. the intercept on the $\lg Q$ axis.
- C. the slope of the graph.
- D. the reciprocal of the slope of the graph.

4. The graph below shows the variation with time t of the acceleration a of a spaceship.



The spaceship is at rest at $t=0$.

The shaded area represents

- A. the distance travelled by the spaceship between $t=0$ and $t=T$.
 - B. the speed of the spaceship at $t=T$.
 - C. the rate at which the speed of the spaceship changes between $t=0$ and $t=T$.
 - D. the rate at which the acceleration changes between $t=0$ and $t=T$.
5. A particle moves from a point P to a point Q in a time T . Which **one** of the following correctly defines both the average velocity and average acceleration of the particle?

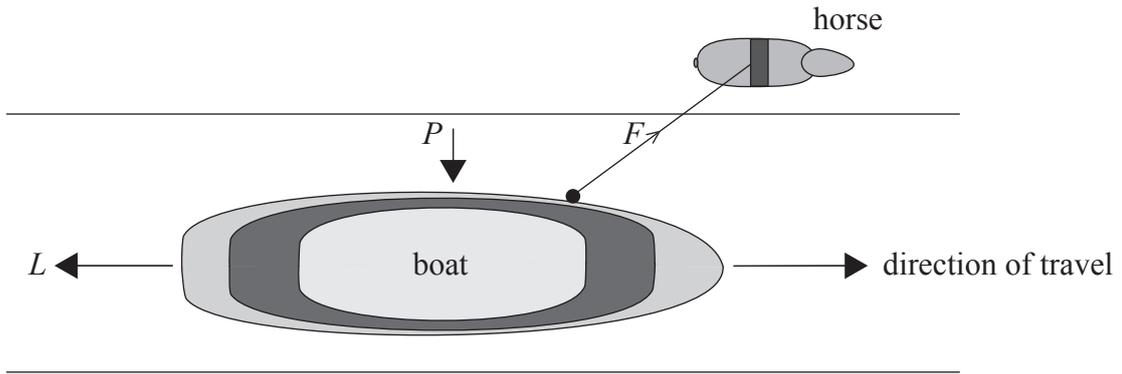
	Average velocity	Average acceleration
A.	$\frac{\text{displacement of Q from P}}{T}$	$\frac{\text{change in speed from P to Q}}{T}$
B.	$\frac{\text{displacement of Q from P}}{T}$	$\frac{\text{change in velocity from P to Q}}{T}$
C.	$\frac{\text{distance between Q and P}}{T}$	$\frac{\text{change in speed from P to Q}}{T}$
D.	$\frac{\text{distance between Q and P}}{T}$	$\frac{\text{change in velocity from P to Q}}{T}$

6. Two stones, X and Y, of different mass are dropped from the top of a cliff. Stone Y is dropped a short time after stone X. Air resistance is negligible.

Whilst the stones are falling, the distance between them will

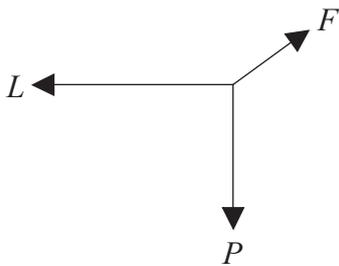
- A. decrease if the mass of Y is greater than the mass of X.
- B. increase if the mass of X is greater than the mass of Y.
- C. decrease whether the mass of X is greater or less than the mass of Y.
- D. increase whether the mass of X is greater or less than the mass of Y.

7. A horse pulls a boat along a canal at constant speed in a straight-line as shown below.

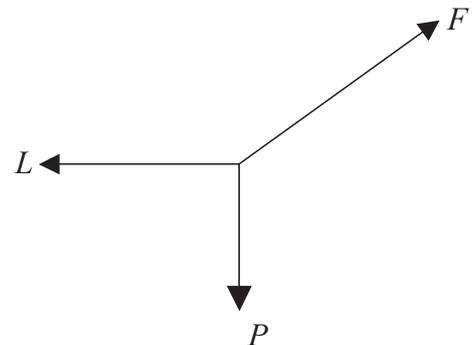


The horse exerts a constant force F on the boat. The water exerts a constant drag force L and a constant force P on the boat. The directions of F , L and P are as shown. Which **one** of the following best represents a free-body diagram for the boat?

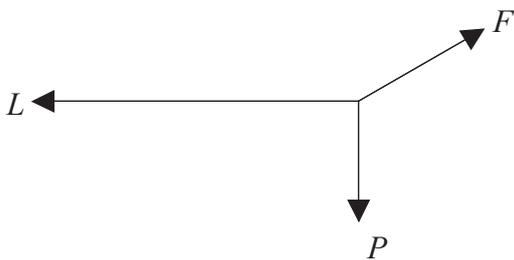
A.



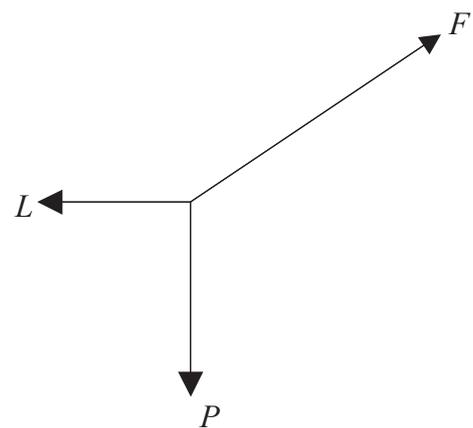
B.



C.

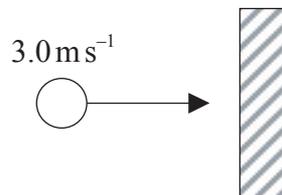


D.

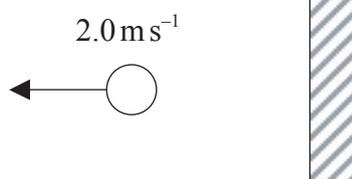


8. If the resultant external force acting on a particle is zero, the particle
- A. must have constant speed.
 - B. must be at rest.
 - C. must have constant velocity.
 - D. must have zero momentum.
9. A ball is travelling horizontally with a speed of 3.0 m s^{-1} . It collides with a vertical wall and rebounds with a horizontal speed of 2.0 m s^{-1} .

before collision



after collision

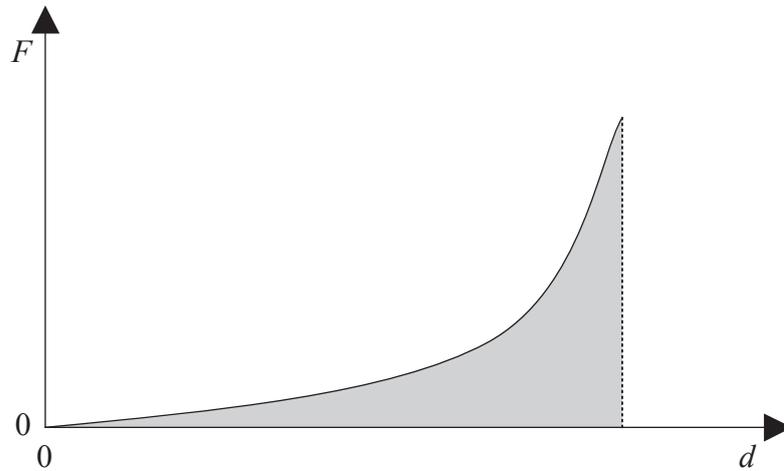


The mass of the ball is 1.0 kg and it is in contact with the wall for 0.20 s .

The magnitude of the force that the ball exerts on the wall is

- A. 0.20 N .
- B. 0.25 N .
- C. 20 N .
- D. 25 N .

10. A particle moves under the influence of a force F . The graph below shows the variation of the force F with the distance d moved by the particle.

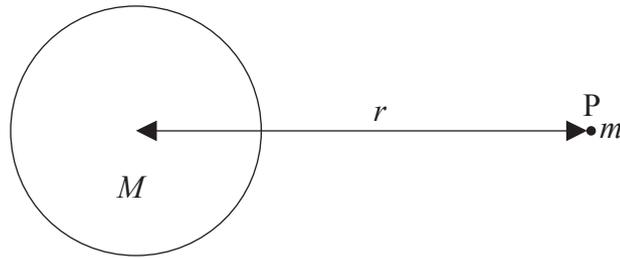


The shaded area is equal to

- A. the average value of F .
 - B. the impulse produced by F .
 - C. the work done by F .
 - D. the power produced by F .
11. A stone is projected horizontally from the top of a cliff. Neglecting air resistance, which **one** of the following correctly describes what happens to the horizontal component of velocity and to the vertical component of velocity ?

	Horizontal component of velocity	Vertical component of velocity
A.	Decreases	Increases
B.	Decreases	Constant
C.	Constant	Constant
D.	Constant	Increases

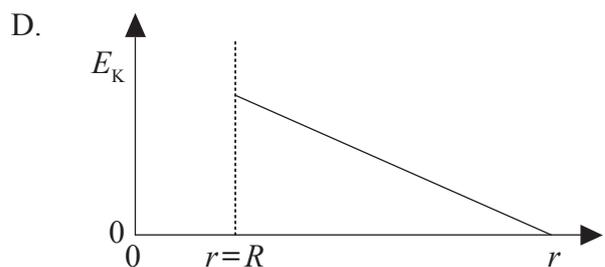
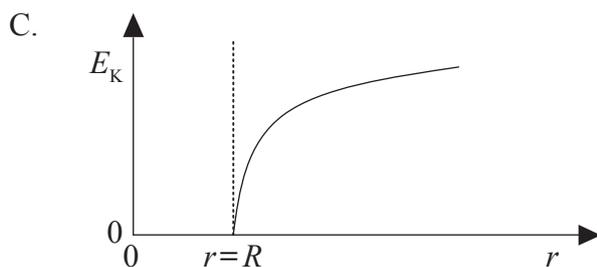
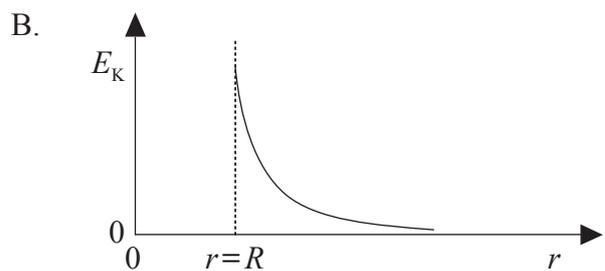
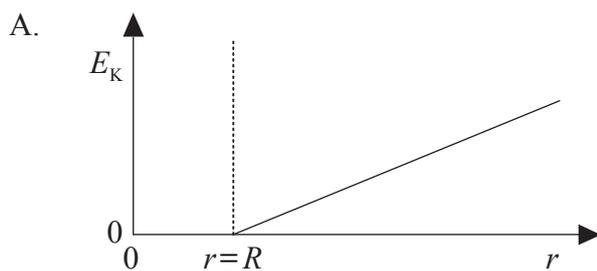
12. A point object of mass m is brought from infinity to the point P, a distance r from the centre of an isolated sphere of mass M .



The work done by the gravitational force in bringing the point object from infinity to point P is

- A. $G \frac{M}{r}$.
- B. $G \frac{Mm}{r}$.
- C. $-G \frac{M}{r}$.
- D. $-G \frac{Mm}{r}$.
13. The kinetic energy E_K of a satellite in orbit varies with its distance r from the centre of a planet of radius R .

Which **one** of the following graphs best shows the variation of E_K with r ?

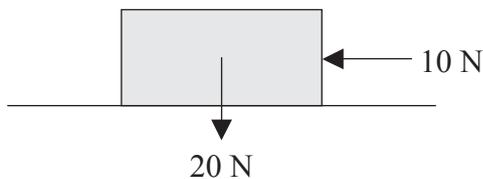


14. Planet X has radius R and mass M . Planet Y has radius $2R$ and mass $8M$.

Which **one** of the following is the correct value of the ratio

$$\frac{\text{gravitational field strength at surface of planet X}}{\text{gravitational field strength at surface of planet Y}}?$$

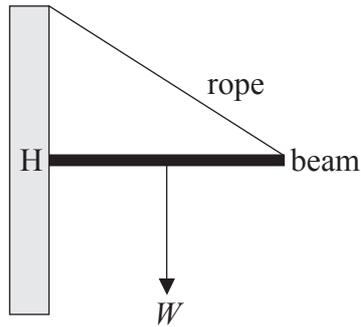
- A. 4
- B. 2
- C. $\frac{1}{2}$
- D. $\frac{1}{4}$
15. A wooden block of weight 20 N is pushed along a rough horizontal surface at constant speed by a horizontal force of 10 N.



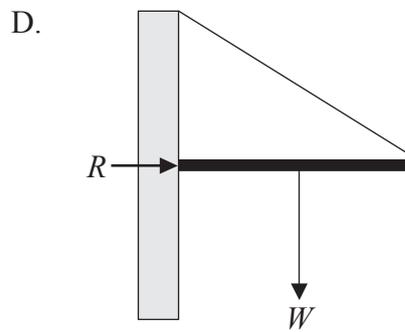
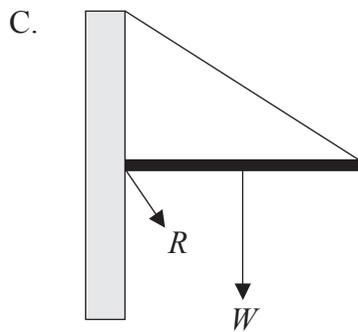
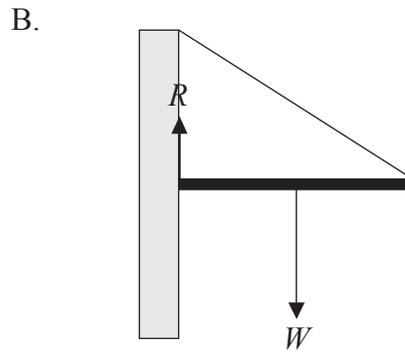
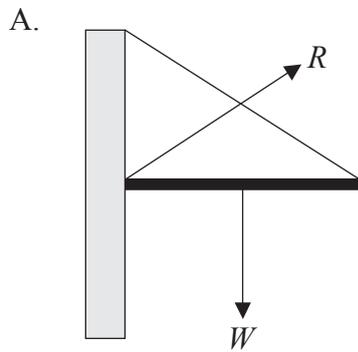
Which **one** of the following is the coefficient of **static** friction between the block and the surface?

- A. Zero
- B. Less than 0.5
- C. Equal to 0.5
- D. Greater than 0.5

16. A uniform beam of weight W is attached to a vertical wall by a hinge H. The beam is held horizontal by a rope as shown below.



Which **one** of the following best shows the direction of the reaction force R at the hinge?

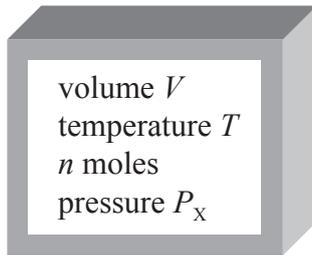


17. Two ideal gases X and Y, are contained in a cylinder at constant temperature. The mass of the atoms of X is m and of Y is $4m$.

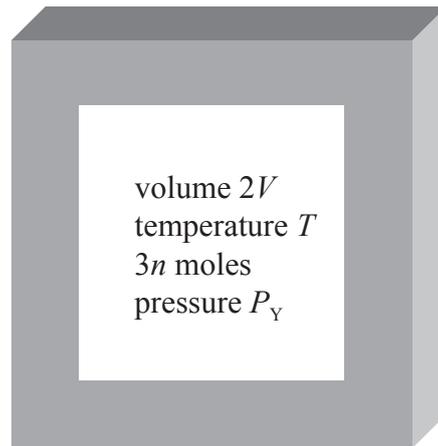
Which **one** of the following is the correct value of the ratio

$$\frac{\text{average kinetic energy of the atoms of Y}}{\text{average kinetic energy of the atoms of X}} ?$$

- A. 1
 - B. 2
 - C. 4
 - D. 16
18. Container X below has volume V and holds n moles of an ideal gas at kelvin temperature T . Container Y has volume $2V$ and holds $3n$ moles of an ideal gas also at kelvin temperature T .



container X



container Y

The pressure of the gas in X is P_X and in Y is P_Y .

The ratio $\frac{P_X}{P_Y}$ is

- A. $\frac{2}{3}$.
- B. $\frac{3}{2}$.
- C. 5.
- D. 6.

19. For a system that undergoes a small change of state,

$$\Delta Q = \Delta U + \Delta W$$

where $+\Delta Q$ = thermal energy transferred to the system
 $+\Delta U$ = increase in internal energy of the system
 $+\Delta W$ = the work done by the system.

In an adiabatic compression of an ideal gas, which **one** of the following is true in respect of ΔQ , ΔU and ΔW ?

	ΔQ	ΔU	ΔW
A.	Zero	Positive	Negative
B.	Zero	Negative	Negative
C.	Positive	Positive	Positive
D.	Negative	Zero	Positive

20. Which **one** of the following is a correct statement of the second law of thermodynamics?

- A. When the state of a system changes its entropy increases.
- B. When the state of a system changes its entropy decreases.
- C. The total entropy of the universe is increasing with time.
- D. The total entropy of the universe is decreasing with time.

21. Which **one** of the following is correct for transfer of energy along a standing wave and for amplitude of vibration of the standing wave?

	Transfer of energy along a standing wave	Amplitude of vibration of the standing wave
A.	None	Constant amplitude
B.	None	Variable amplitude
C.	Energy is transferred	Constant amplitude
D.	Energy is transferred	Variable amplitude

22. Two pipes P and Q are of the same length. Pipe P is closed at one end and pipe Q is open at both ends. The fundamental frequency (first harmonic) of the closed pipe P is 220 Hz.

The best estimate for the fundamental frequency of the open pipe Q is

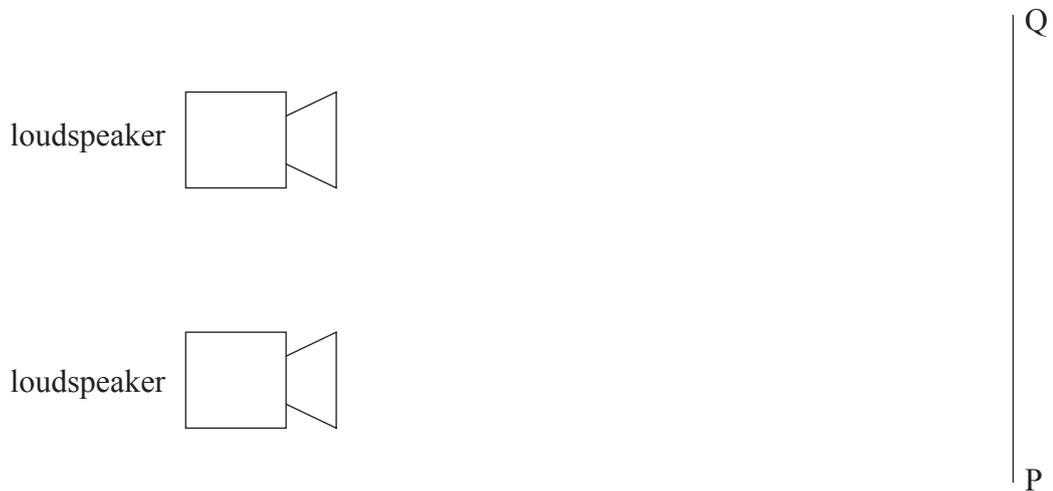
- A. 880 Hz.
 - B. 440 Hz.
 - C. 110 Hz.
 - D. 55 Hz.
23. The sounds from two sources interfere. The resulting sound has a frequency of 252 Hz with a beat frequency of 4.00 Hz.

The frequencies of the sources are

- A. 254 Hz and 250 Hz.
- B. 256 Hz and 248 Hz.
- C. 252 Hz and 248 Hz.
- D. 252 Hz and 256 Hz.

24. In order that the light from two sources produces an observable interference pattern, it is necessary that
- A. the sources must be point sources.
 - B. the light emitted by the sources must be monochromatic.
 - C. the light from each source must be of the same intensity.
 - D. the light from the sources must be coherent.

25. In the diagram below (not to scale), each of the loudspeakers emits a continuous sound of the same frequency.

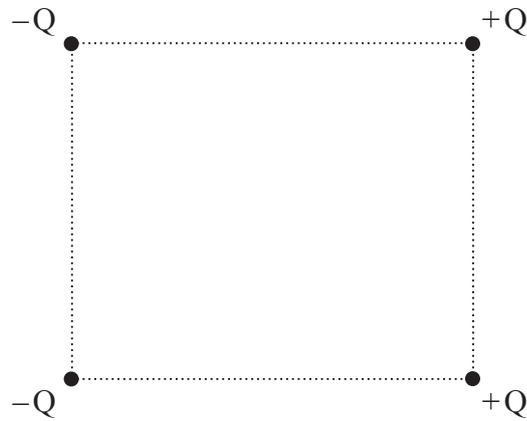


A microphone moved along the line PQ detects a series of maximum and minimum sound intensities.

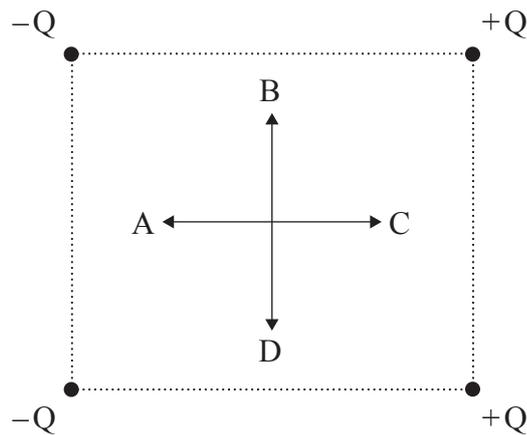
Which **one** of the following actions on its own, will lead to an **increase** in the distance between the maxima of sound intensity?

- A. Decreasing the frequency of the sound emitted by the loudspeakers.
- B. Increasing the frequency of the sound emitted by the loudspeakers.
- C. Increasing the separation of the loudspeakers.
- D. Decreasing the distance of the loudspeakers from the line PQ.

26. Four point charges are held at the four corners of a square as shown below. The charges have equal magnitude and the sign of each charge is also shown.

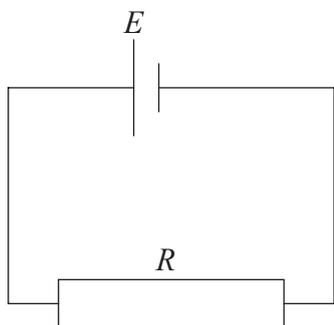


Which arrow best shows the direction of the resultant electric field at the centre of the square due to the point charges?

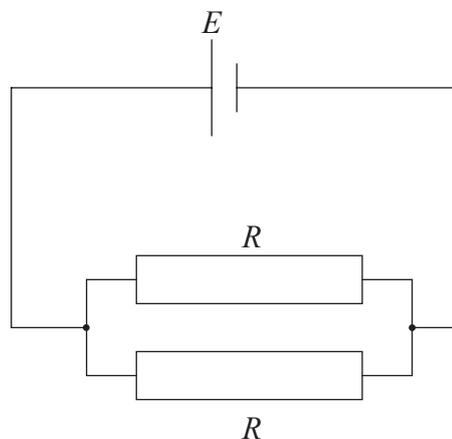


27. In the two circuits X and Y below, each cell has an e.m.f. E and negligible internal resistance. Each resistor has a resistance R .

circuit X



circuit Y

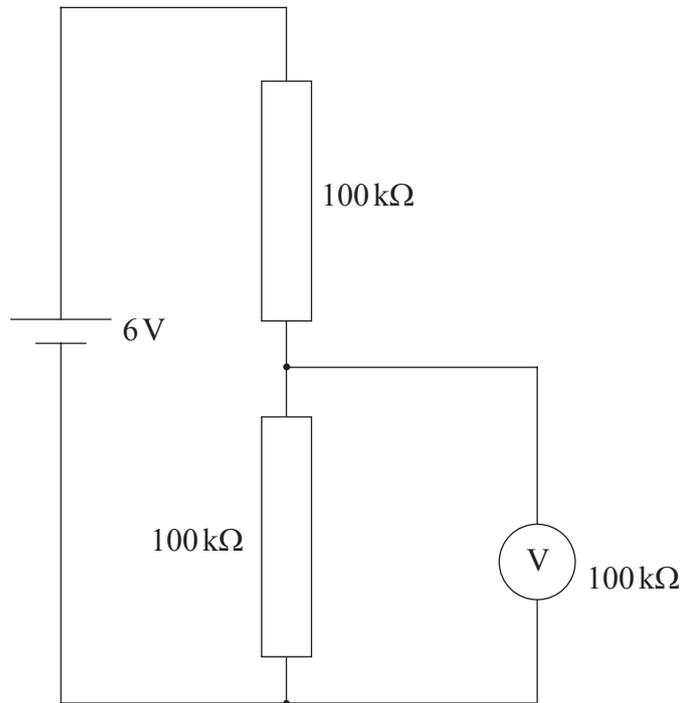


The power dissipated in circuit X is P .

The best estimate for the power dissipated in circuit Y is

- A. $\frac{P}{4}$.
- B. $\frac{P}{2}$.
- C. $2P$.
- D. $4P$.
28. The drift velocity of the electrons in a copper wire in which there is an electric current is
- A. equal to the speed of light.
- B. close to that of the speed of light.
- C. of the order of a few kilometres per second.
- D. of the order of a few millimetres per second.

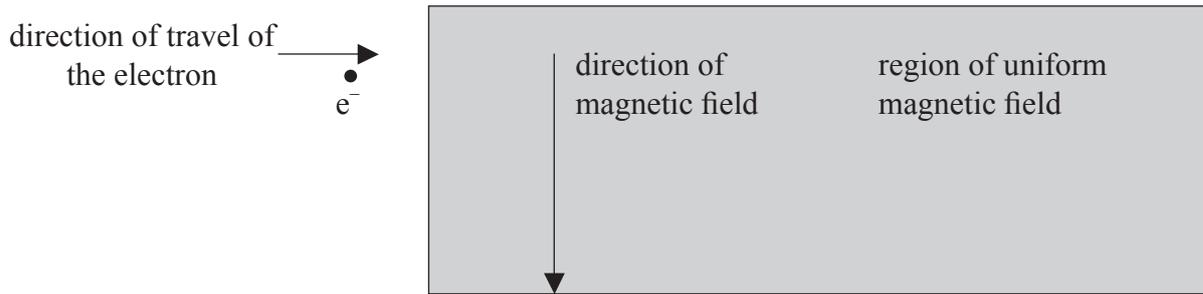
29. In the circuit below, the voltmeter has a resistance $100\text{ k}\Omega$. The battery has negligible internal resistance and e.m.f. 6 V .



The reading on the voltmeter is

- A. 0 V .
- B. 2 V .
- C. 3 V .
- D. 4 V .

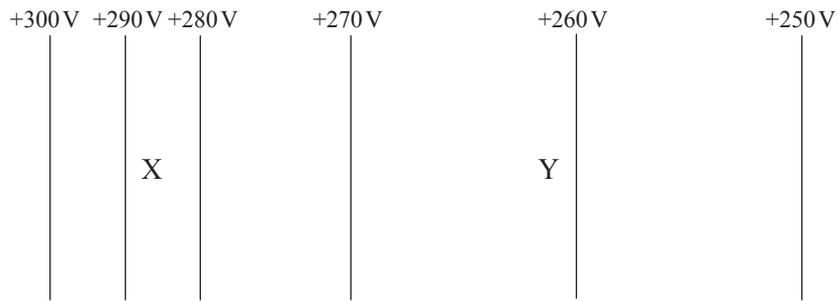
30. An electron is travelling in the direction shown and enters a region of uniform magnetic field.



On entering the field the direction of the force acting on the electron is

- A. into the plane of the paper.
- B. out of the plane of the paper.
- C. towards the top of the page.
- D. towards the bottom of the page.

31. The diagram below shows some equipotential lines in an electric field.



The magnitude of the electric field strength at X is E_X and at Y is E_Y .

Which **one** of the following correctly compares E_X and E_Y and gives the correct direction of the electric field?

	Magnitude of field strengths	Direction of field
A.	$E_X > E_Y$	$X \rightarrow Y$
B.	$E_X > E_Y$	$Y \rightarrow X$
C.	$E_X < E_Y$	$X \rightarrow Y$
D.	$E_X < E_Y$	$Y \rightarrow X$

32. A thin copper ring encloses an area S . The area is linked by magnetic flux that is increasing. The rate of change of the magnetic flux from time $t=0$ to time $t=T$ is R .

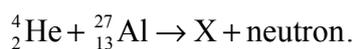
The e.m.f. induced in the copper ring during the time $t=0$ to time $t=T$ is

- A. R .
- B. RS .
- C. RST .
- D. $\frac{RS}{T}$.

33. The maximum value of an sinusoidal alternating current in a resistor of resistance R is I_0 . The maximum current is increased to $2I_0$.

Assuming that the resistance of the resistor remains constant, the **average** power dissipated in the resistor is now

- A. $\frac{1}{2}I_0^2R$.
- B. I_0^2R .
- C. $2I_0^2R$.
- D. $4I_0^2R$.
34. When the isotope aluminium-27 is bombarded with alpha particles, the following nuclear reaction can take place



Which **one** of the following correctly gives the atomic (proton) number and mass (nucleon) number of the nucleus X?

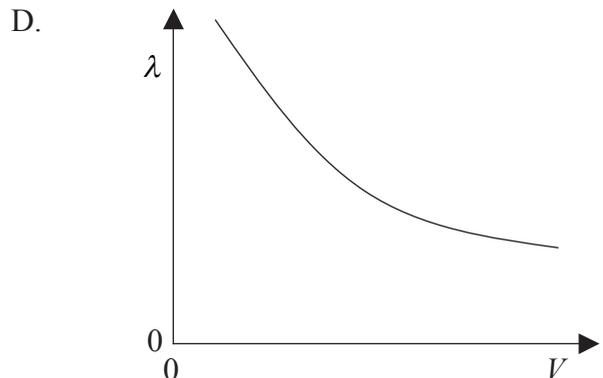
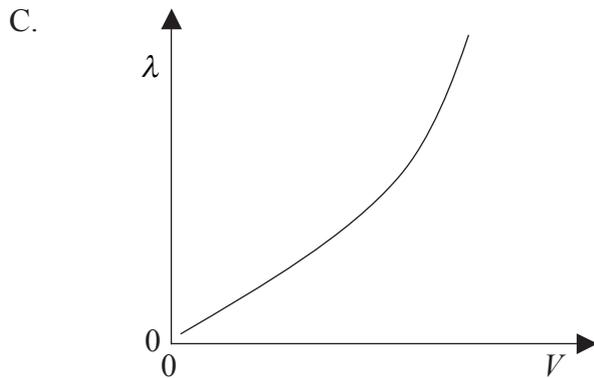
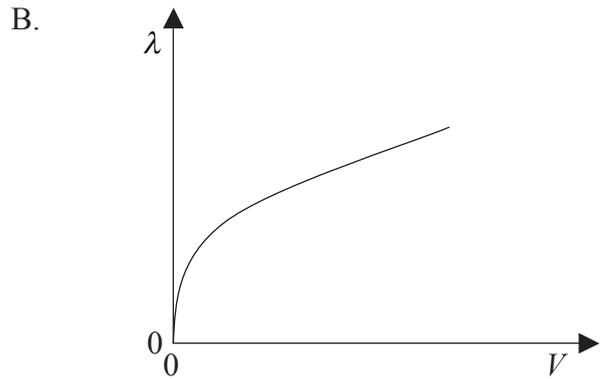
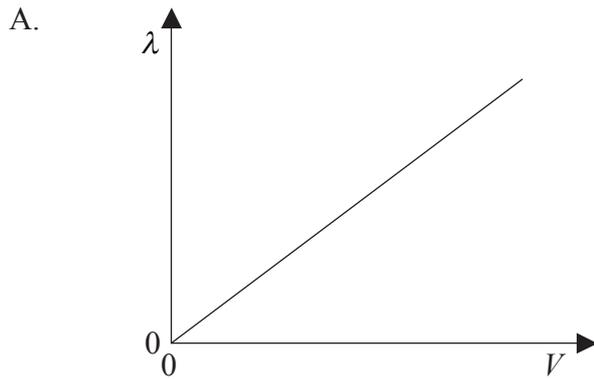
	Proton number	Nucleon number
A.	15	30
B.	16	31
C.	30	15
D.	31	16

35. A certain metal surface has a photoelectric threshold frequency f_0 . The Planck constant is h and the electron charge is e .

For the values of f_0 , h and e given in SI units, which **one** of the following is the correct expression for the photoelectric work function of the metal surface measured in electron volts?

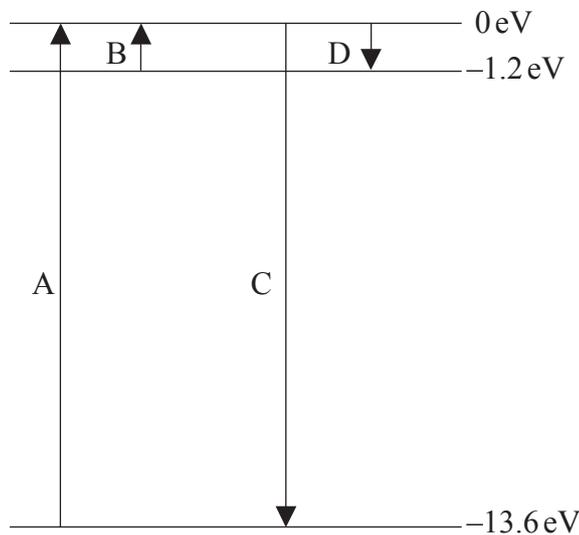
- A. hf_0
- B. hf_0e
- C. $\frac{hf_0}{e}$
- D. $\frac{h}{f_0}$

36. An electron is accelerated from rest through a potential difference V . Which **one** of the following best shows the variation of the de Broglie wavelength λ of the electron with potential difference V ?



37. Which **one** of the following provides evidence for the existence of atomic energy levels?
- A. The photoelectric effect
 - B. Characteristic X-ray spectra
 - C. Matter waves
 - D. Alpha particle scattering

38. The diagram below shows some possible electron transitions between three principal energy levels in the hydrogen atom. Which electron transition is associated with the absorption of a photon of the longest wavelength?



39. A nucleus of the isotope potassium-40 (${}^{40}_{19}\text{K}$) decays to form a nucleus argon-40 (${}^{40}_{18}\text{Ar}$). Which **one** of the following correctly identifies the other two particles resulting from this decay?
- A. β^- and ν
 - B. β^- and $\bar{\nu}$
 - C. β^+ and ν
 - D. β^+ and $\bar{\nu}$

40. The three classes of observed particles are
- A. leptons, mesons, bosons.
 - B. leptons, hadrons, exchange bosons.
 - C. mesons, bosons, exchange bosons.
 - D. mesons, baryons, leptons.
-