

1. Which of the following contains only **fundamental** SI units?

| | | | |
|----|----------|--------|----------|
| A. | ampere | newton | second |
| B. | volt | second | kelvin |
| C. | mole | ampere | kilogram |
| D. | kilogram | metre | tesla |

2. The mass of a body is measured with an uncertainty of 2.0% and its volume with an uncertainty of 10%. What is the uncertainty in the density of the body?

- A. 0.2%
- B. 5.0%
- C. 12%
- D. 20%

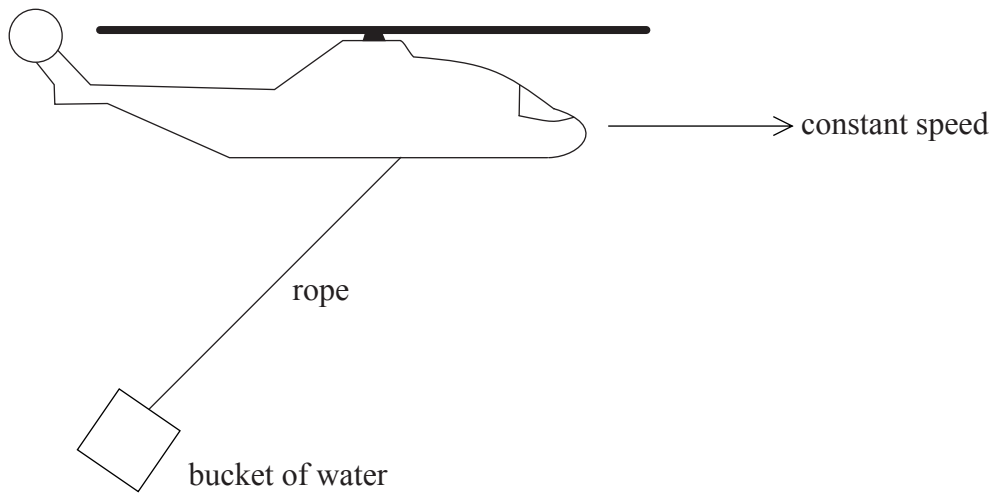
3. The molar mass of water is 18 g. The approximate number of water molecules in a glass of water is

- A. 10^{22} .
- B. 10^{25} .
- C. 10^{28} .
- D. 10^{31} .

4. Both random and systematic errors are present in the measurement of a particular quantity. What changes, if any, would repeated measurements of this quantity have on the random and systematic errors?

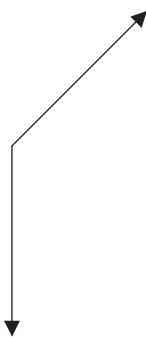
| | Random | Systematic |
|----|---------------|-------------------|
| A. | reduced | reduced |
| B. | reduced | unchanged |
| C. | unchanged | reduced |
| D. | unchanged | unchanged |

5. A fire-fighting helicopter is flying at constant speed along a horizontal straight-line carrying a bucket of water as shown in the diagram below. The rope to the bucket makes a fixed angle with the vertical.

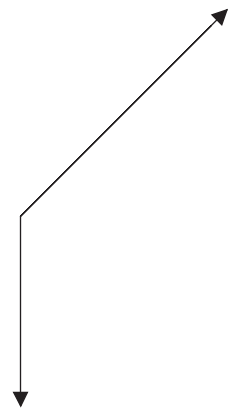


Which of the following diagrams is the correct free body diagram of the forces acting on the bucket?

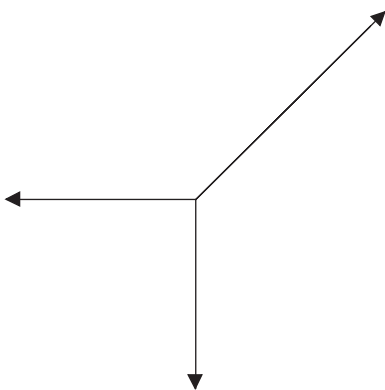
A.



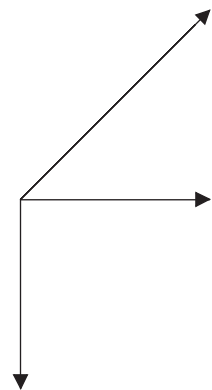
B.



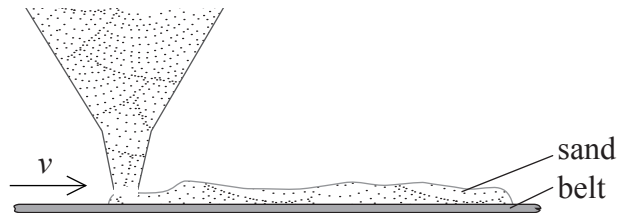
C.



D.

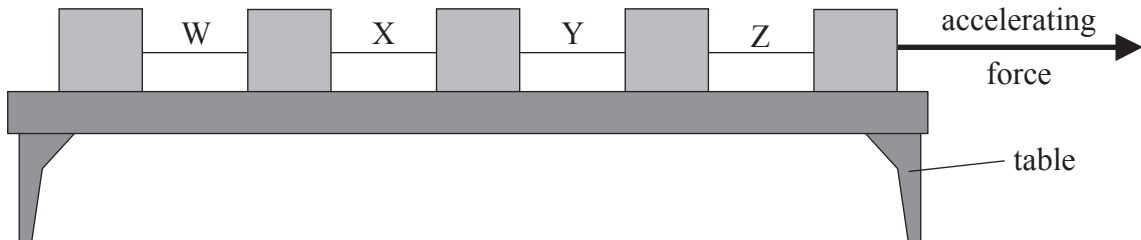


6. Sand falls vertically on a conveyor belt at a rate of $m \text{ kg s}^{-1}$.



In order to keep the belt moving at constant speed v the horizontal force that must be exerted on the belt is

- A. mv .
 - B. $\frac{1}{2}mv$.
 - C. mv^2 .
 - D. $\frac{1}{2}mv^2$.
7. The diagram below shows five wooden blocks joined by inelastic strings. A constant force accelerates the blocks to the right on a frictionless horizontal table.



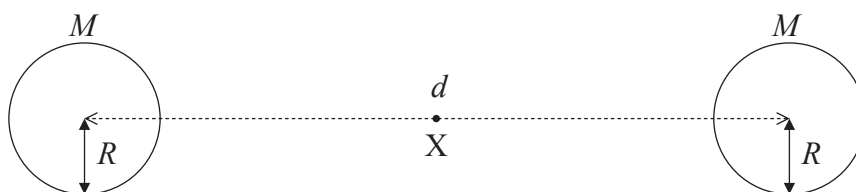
In which string is the tension the greatest?

- A. W
- B. X
- C. Y
- D. Z

8. A force of magnitude F_1 accelerates a body of mass m from rest to a speed v . A force of magnitude F_2 accelerates a body of mass $2m$ from rest to a speed $2v$.

The ratio $\frac{\text{work done by } F_2}{\text{work done by } F_1}$ is

- A. 2.
 B. 4.
 C. 8.
 D. 16.
9. The centres of two isolated spherical stars each of mass M and radius R are separated by a distance d as shown in the diagram below.



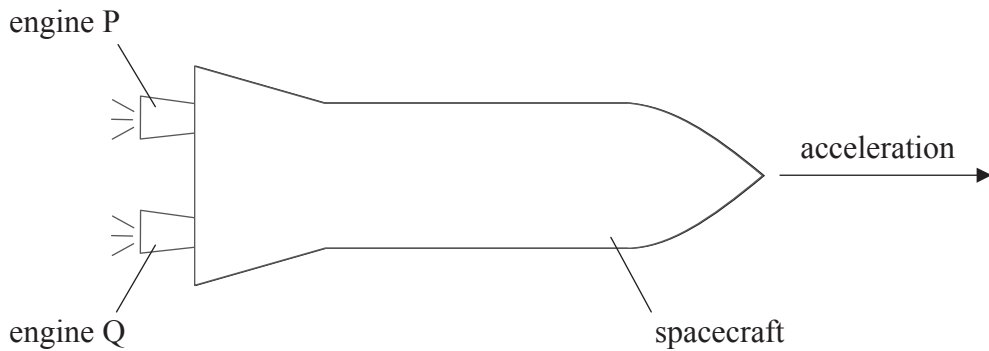
The distance d is very large compared to R . Point X is mid-way between the stars. The gravitational potential at point X due to the two stars is

- A. $-\frac{4GM}{d}$.
 B. $-\frac{2GM}{R}$.
 C. $-\frac{GM}{d}$.
 D. zero.

10. Two satellites, X and Y, move in circular orbits about the Earth. The orbital period of satellite X is eight times that of satellite Y.

The ratio $\frac{\text{orbital radius of satellite X}}{\text{orbital radius of satellite Y}}$ is

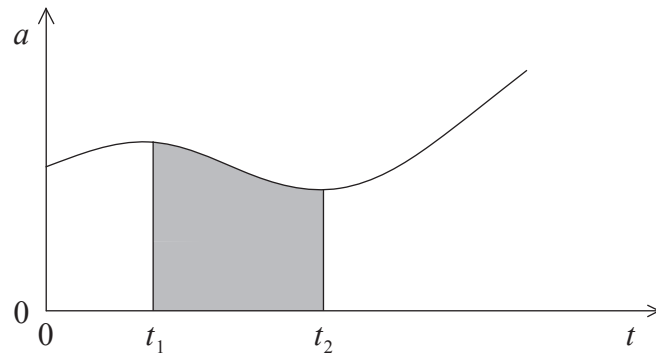
- A. 2.
 - B. 4.
 - C. 8.
 - D. 16.
11. A spacecraft accelerates along a straight-line in outer space under the action of two engines P and Q as shown in the diagram below.



The engine P fails. Which of the following gives the state of equilibrium of the spacecraft?

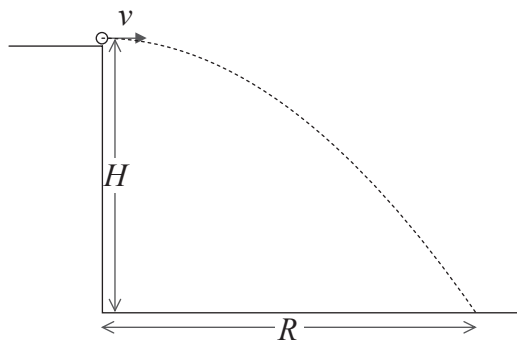
| | Translational | Rotational |
|----|----------------------|-------------------|
| A. | yes | yes |
| B. | yes | no |
| C. | no | yes |
| D. | no | no |

12. The graph below shows the variation with time t of the acceleration a of a body moving in a straight-line.



The shaded area represents

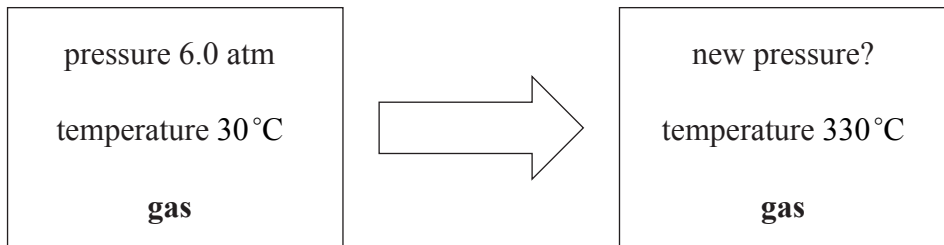
- A. the change in velocity from t_1 to t_2 .
 - B. the velocity at t_2 .
 - C. the average velocity between t_1 and t_2 .
 - D. the velocity at t_1 .
13. A particle is projected horizontally with speed v from a height H . It lands a horizontal distance R from the point of launch as shown in the diagram below.



A second particle is projected horizontally from the same height with speed $2v$. Neglecting air resistance the horizontal distance travelled by this particle is

- A. R .
- B. $\sqrt{2}R$.
- C. $2R$.
- D. $4R$.

14. Two bodies are brought into thermal contact with each other. No thermal energy transfer takes place between the bodies. It may be deduced therefore, that the bodies must have the same
- A. specific heat capacity.
 - B. heat capacity.
 - C. temperature.
 - D. internal energy.
15. An ideal gas is kept in a container of fixed volume at a temperature of 30°C and a pressure of 6.0 atm. The gas is heated at constant volume to a temperature of 330°C.



The new pressure of the gas is about

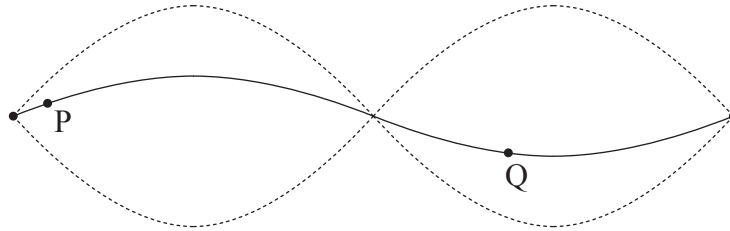
- A. 0.60 atm.
 - B. 3.0 atm.
 - C. 12 atm.
 - D. 66 atm.
16. A liquid is heated in a well-insulated container. The power input to the liquid and its specific heat capacity are known.
- Which of the following quantities must be known in order to calculate the rate at which the temperature increases?
- A. The time for which the liquid is heated
 - B. The initial temperature of the liquid
 - C. The final temperature of the liquid
 - D. The mass of the liquid

17. The work done by an ideal gas as it expands isothermally from a state of volume V_1 to a volume V_2 is W .

The work done by the gas as it expands adiabatically from the same initial state to a state of volume V_2 is

- A. zero.
 - B. less than W but not zero.
 - C. W .
 - D. greater than W .
18. The entropy of a system is a measure of the system's
- A. disorder.
 - B. mean energy.
 - C. temperature.
 - D. total energy.

19. A string with both ends fixed is made to vibrate in the second harmonic mode as shown by the dashed lines in the diagram below.



The solid line shows a photograph of the string at a particular instant of time. Two points on the string have been marked P and Q.

Which of the following correctly compares both the period of vibration of P and Q and the average speed of P and Q?

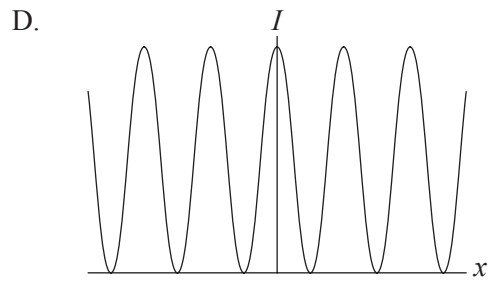
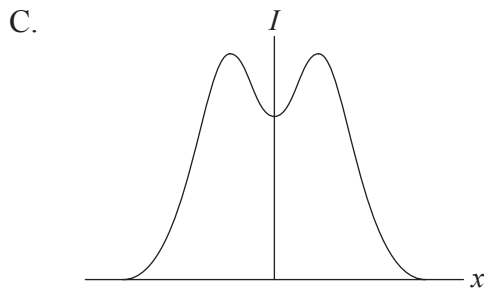
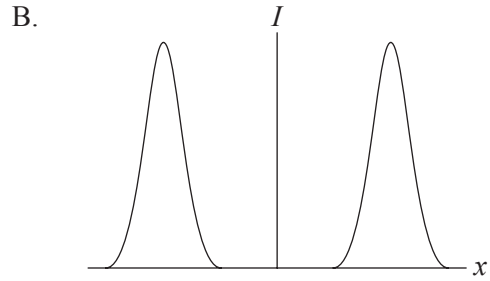
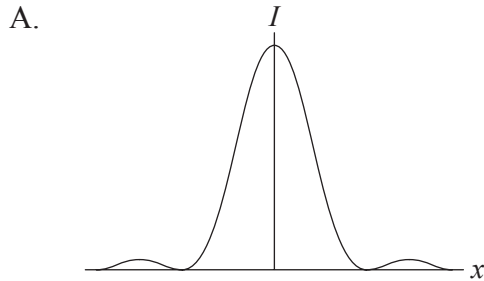
| | Period | Average speed |
|----|---------------|----------------------|
| A. | same | same |
| B. | same | different |
| C. | different | same |
| D. | different | different |

20. The phenomenon of diffraction is associated with

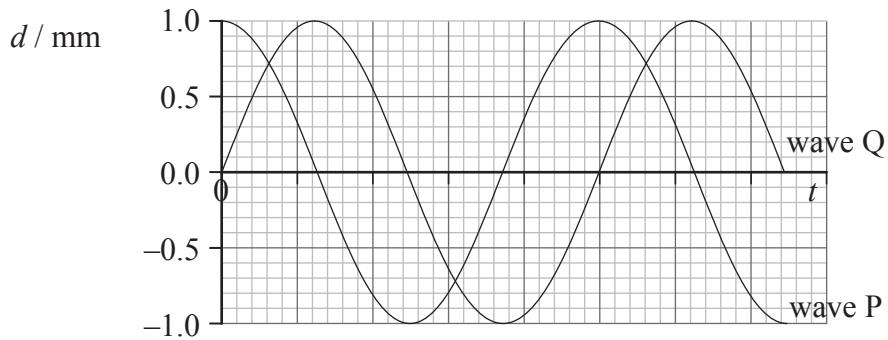
- A. sound waves only.
- B. light waves only.
- C. water waves only.
- D. all waves.

21. Monochromatic, coherent light is incident normally on a double slit. The width of each slit is small compared to their separation. After passing through the slits the light is brought to a focus on a screen.

Which of the following diagrams best shows the variation with distance x along the screen of the intensity I of the light?



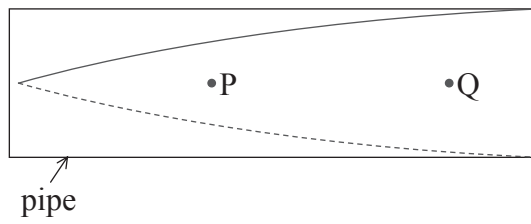
22. The graph below shows the variation with time t of the separate displacements d of a medium, at a particular point in the medium due to two waves, P and Q.



The amplitude of the wave resulting from the interference of P and Q is

- A. 0.0 mm.
- B. 1.0 mm.
- C. 1.4 mm.
- D. 2.0 mm.

23. The diagram below represents the fundamental (first harmonic) standing wave of sound inside a pipe.



Which of the following correctly represents the displacement of the air at P and Q?

| | P | Q |
|----|---|---|
| A. | ↔ | ↔ |
| B. | ↔ | ↔ |
| C. | ↕ | ↕ |
| D. | ↕ | ↕ |

24. One end of a long string is vibrated at a constant frequency f . A travelling wave of wavelength λ and speed v is set up on the string.

The frequency of vibration is doubled but the tension in the string is unchanged. Which of the following shows the wavelength and speed of the new travelling wave?

| | Wavelength | Speed |
|----|---------------------|-------|
| A. | $\frac{\lambda}{2}$ | v |
| B. | $\frac{\lambda}{2}$ | $2v$ |
| C. | 2λ | v |
| D. | 2λ | $2v$ |

25. A neutral conducting sphere is placed far away from a smaller, positively charged conducting sphere. The spheres are joined for a short period of time by a metallic wire.

How do the charge and the electric potential of the spheres compare after the wire is removed?

| | Charge | Electric Potential |
|----|-----------|--------------------|
| A. | different | different |
| B. | different | same |
| C. | same | different |
| D. | same | same |

26. A proton and an alpha particle are accelerated from rest through the same potential difference.

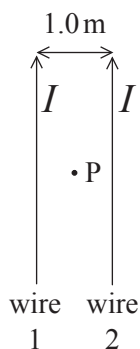
After acceleration the ratio $\frac{\text{kinetic energy of alpha particle}}{\text{kinetic energy of proton}}$ is

- A. $\sqrt{2}$.
- B. 2.
- C. $2\sqrt{2}$.
- D. 4.
27. Three identical resistors of constant resistance are connected in series to a battery of negligible internal resistance. The total power dissipated in the circuit is P .

The three resistors are now connected in parallel. The total power dissipated is

- A. $\frac{P}{3}$.
- B. P .
- C. $3P$.
- D. $9P$.

28. The diagram below shows two long parallel wires, 1.0 m apart, on the plane of the page. Each wire carries a current I in the same direction.

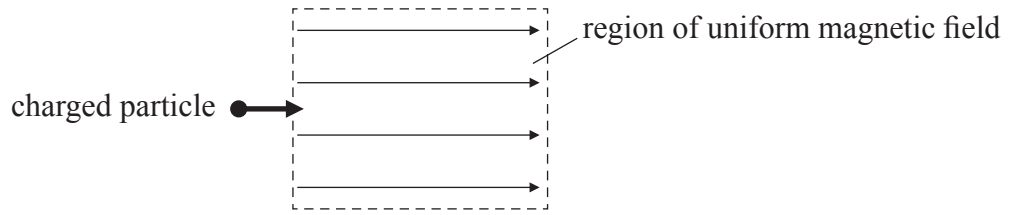


Point P is on the plane of the page midway between the two wires. The magnitude of the magnetic field strength at point P due to wire 1 alone is B_0 .

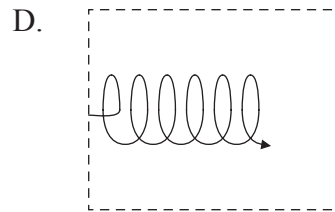
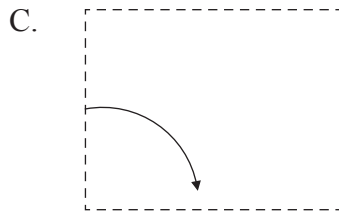
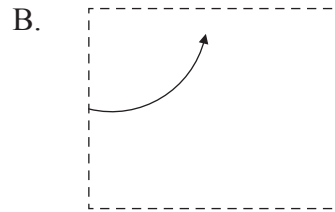
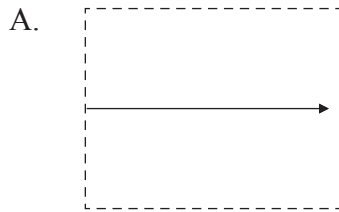
The magnitude of the magnetic field strength at point P due to both wires is

- A. 0.
- B. $\frac{1}{2} B_0$.
- C. B_0 .
- D. $2B_0$.

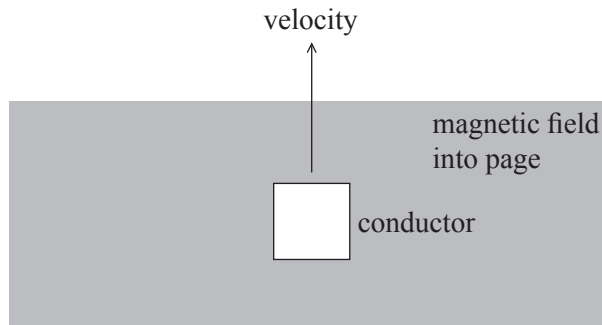
29. A positively charged particle enters a region of uniform magnetic field. The direction of the particle's velocity is parallel to the direction of the magnetic field as shown in the diagram below.



Which of the following diagrams correctly shows the path of the charged particle while in the region of magnetic field?

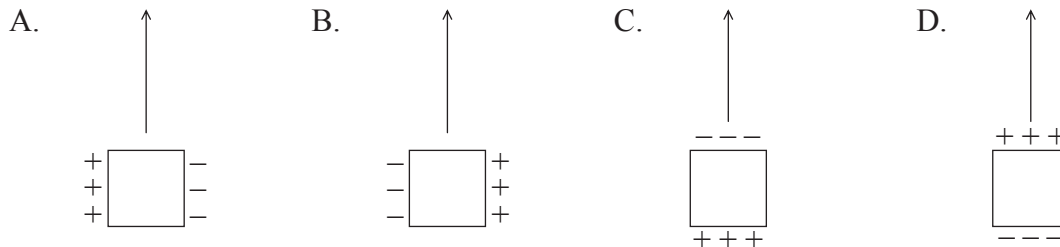


30. A conductor in the shape of a solid square is moving with constant velocity in a region of magnetic field as shown in the diagram below.



The direction of the field is into the plane of the page.

Which of the following diagrams correctly represents the separation of the induced charges?



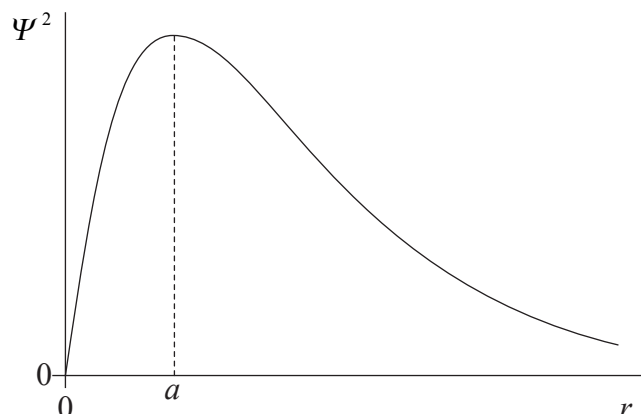
31. A transformer has a primary coil with N_p turns and a secondary coil with N_s turns. An alternating voltage supply of frequency f and r.m.s. value V_p is connected to the primary coil.

Which of the following correctly gives the frequency and r.m.s. voltage in the secondary coil?

| | Frequency | Voltage |
|----|---------------------|-----------------------|
| A. | $\frac{N_s}{N_p} f$ | $\frac{N_p}{N_s} V_p$ |
| B. | f | $\frac{N_p}{N_s} V_p$ |
| C. | $\frac{N_p}{N_s} f$ | $\frac{N_s}{N_p} V_p$ |
| D. | f | $\frac{N_s}{N_p} V_p$ |

32. The Geiger-Marsden alpha particle scattering experiment provides evidence for the existence of
- atomic nuclei.
 - neutrons.
 - protons.
 - nuclear energy levels.
33. A freshly prepared sample of a radioactive isotope contains N_0 atoms. The decay constant of the isotope is λ . The initial activity of the sample is
- $\frac{N_0}{\lambda}$.
 - $\frac{N_0 \ln 2}{\lambda}$.
 - λN_0 .
 - $N_0 e^{-\lambda}$.
34. A nucleus of sodium (${}^{22}_{11}\text{Na}$) undergoes beta-plus (β^+) decay into a nucleus of neon (Ne). Which of the following is the correct nuclear reaction for this decay?
- ${}^{22}_{11}\text{Na} \rightarrow {}^{22}_{12}\text{Ne} + {}^0_{-1}\text{e} + {}^0_0\bar{\nu}$
 - ${}^{22}_{11}\text{Na} \rightarrow {}^{22}_{10}\text{Ne} + {}^0_{+1}\text{e} + {}^0_0\nu$
 - ${}^{22}_{11}\text{Na} \rightarrow {}^{22}_{10}\text{Ne} + {}^0_{+1}\text{e} + {}^0_0\bar{\nu}$
 - ${}^{22}_{11}\text{Na} \rightarrow {}^{22}_{12}\text{Ne} + {}^0_{-1}\text{e} + {}^0_0\nu$
35. In an X-ray tube, the nature of the target material determines the
- minimum wavelength of the X-rays.
 - maximum wavelength of the X-rays.
 - wavelength at which most of the X-rays are emitted.
 - wavelengths of the characteristic spectral lines.

36. The graph below shows the variation with distance r from the nucleus of the square of the wave function, Ψ^2 , of a hydrogen atom according to the Schrödinger theory.



It may be deduced that the distance of the electron from the nucleus

- A. is most likely to be near a .
 - B. is always a .
 - C. is always less than a .
 - D. is always greater than a .
37. A proton and an alpha particle have the same de Broglie wavelength.

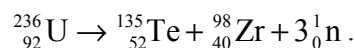
The ratio $\frac{\text{speed of proton}}{\text{speed of alpha particle}}$ is

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

38. Photons of wavelength λ are incident on a clean metallic surface in a vacuum. The number of photons incident on the surface per second is N . It is observed that no electrons are emitted from the surface.

Which of the following changes could result in electrons being emitted from the surface?

- A. Increase λ
 - B. Decrease λ
 - C. Increase N
 - D. Decrease N
39. One possible fission reaction can be represented by the equation



E_{U} , E_{Te} and E_{Zr} are the binding energies of uranium, tellurium and zirconium respectively. Binding energy is defined as a positive quantity. It may be deduced that

- A. $E_{\text{U}} = E_{\text{Te}} + E_{\text{Zr}}$.
 - B. $E_{\text{U}} > E_{\text{Te}} + E_{\text{Zr}}$.
 - C. $E_{\text{U}} < E_{\text{Te}} + E_{\text{Zr}}$.
 - D. $E_{\text{U}} = E_{\text{Te}} - E_{\text{Zr}}$.
40. The decay $n \rightarrow \pi^0 + \pi^0$ of a neutron into two π^0 mesons does not occur because it violates the law of conservation of
- A. baryon number.
 - B. lepton number.
 - C. electric charge.
 - D. momentum.