1. The volume V of a cylinder of height h and radius r is given by the expression

$$V = \pi r^2 h.$$

In a particular experiment, r is to be determined from measurements of V and h. The uncertainties in V and in h are as shown below.

V	$\pm 7\%$
h	$\pm 3\%$

The approximate uncertainty in r is

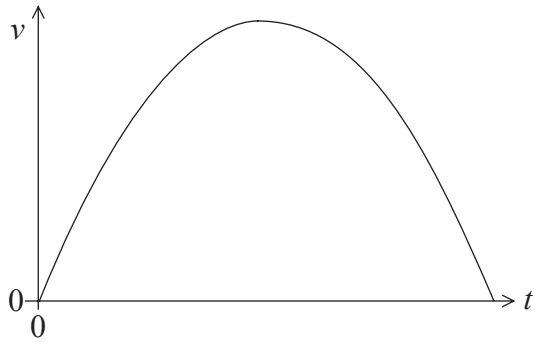
A. 10%.

B. 5%.

C. 4%.

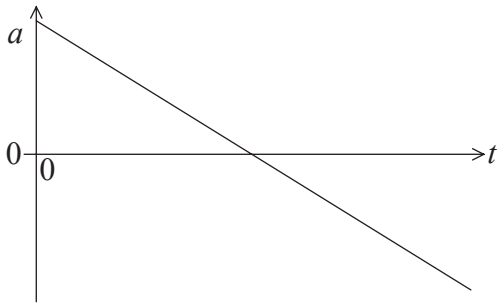
D. 2%.

2. The graph below shows the variation with time t of the velocity v of an object moving on a straight-line.

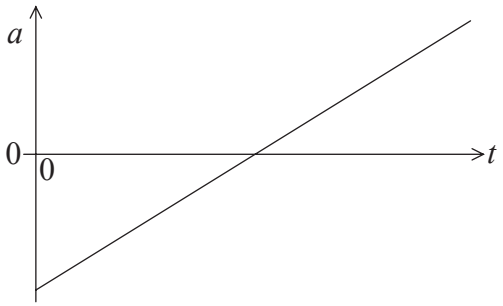


Which of the graphs below best represents the variation with time t of the acceleration a of the object?

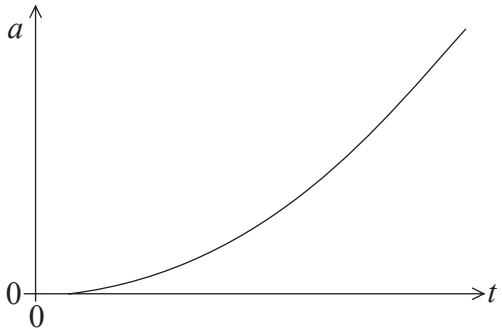
A.



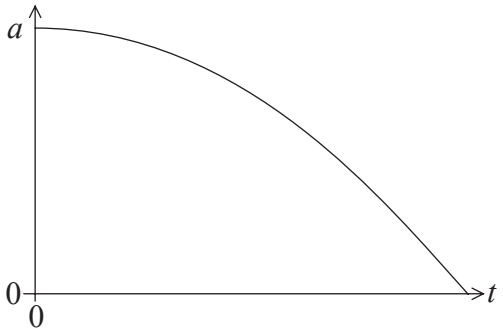
B.



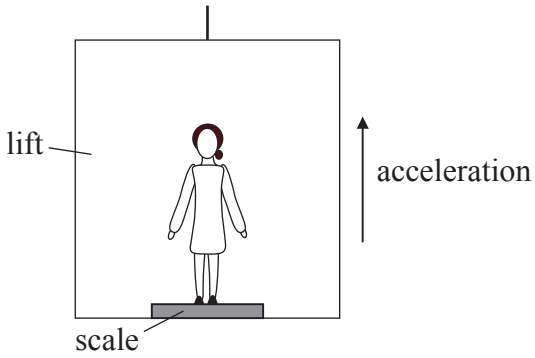
C.



D.



3. 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. $R-W$.

7. A spacecraft orbits Earth. An astronaut inside the spacecraft feels "weightless" because

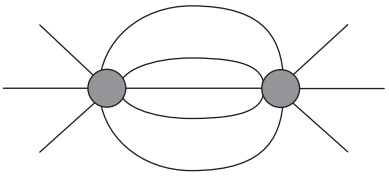
A. the gravitational field in the spacecraft is negligible.

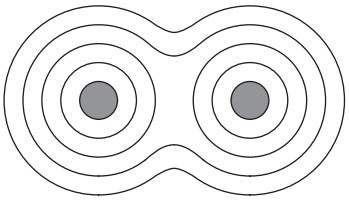
B. the Earth exerts equal forces on the spacecraft and the astronaut.

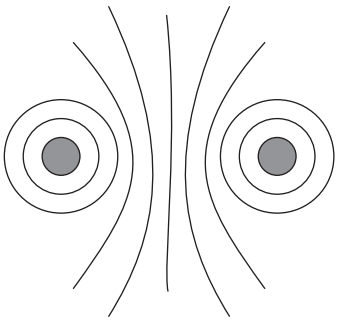
C. the spacecraft and the astronaut have the same acceleration towards the Earth.

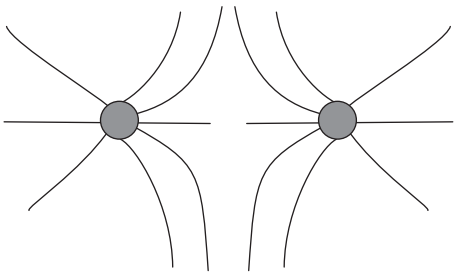
D. the spacecraft and the astronaut exert equal and opposite forces on each other.

8. Which of the following diagrams best represents the gravitational equipotential surfaces due to two equal spherical masses?

A. 

B. 

C. 

D. 

9. The internal energy of a solid substance is equal to the

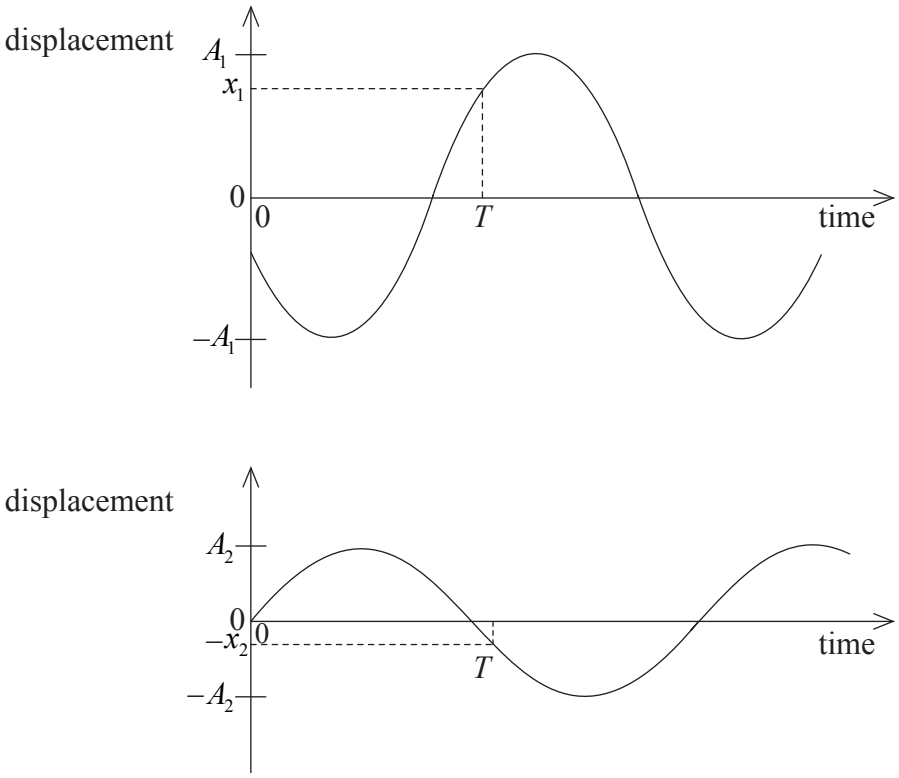
A. average kinetic energy of the molecules.

B. total kinetic energy of the molecules.

C. total potential energy of the molecules.

D. total potential and total kinetic energy of the molecules.

15. The two graphs show the variation with time of the individual displacements of two waves as they pass through the same point.



The displacement of the resultant wave at the point at time T is equal to

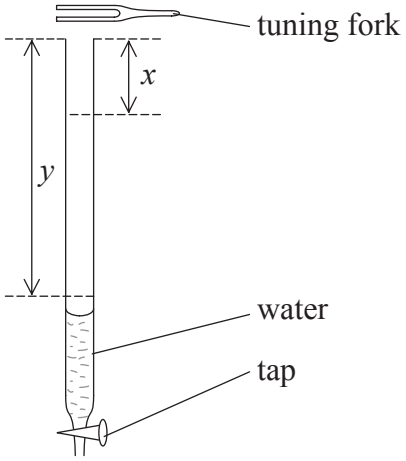
A. $x_1 + x_2$.

B. $x_1 - x_2$.

C. $A_1 + A_2$.

D. $A_1 - A_2$.

16. A tube is filled with water and a vibrating tuning fork is held above its open end.



The tap at the base of the tube is opened. As the water runs out, the sound is loudest when the water level is a distance x below the top of the tube. A second loud sound is heard when the water level is a distance y below the top. Which of the following is a correct expression for the wavelength λ of the sound produced by the tuning fork?

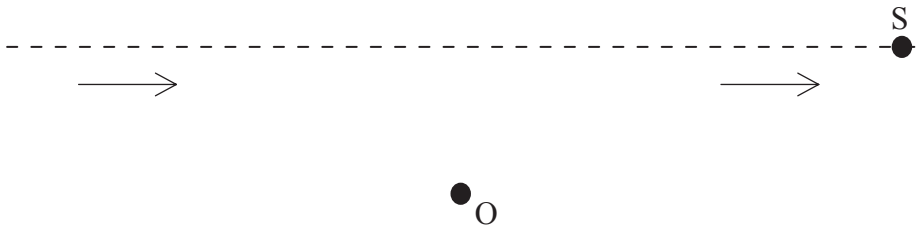
A. $\lambda = y$

B. $\lambda = 2x$

C. $\lambda = y - x$

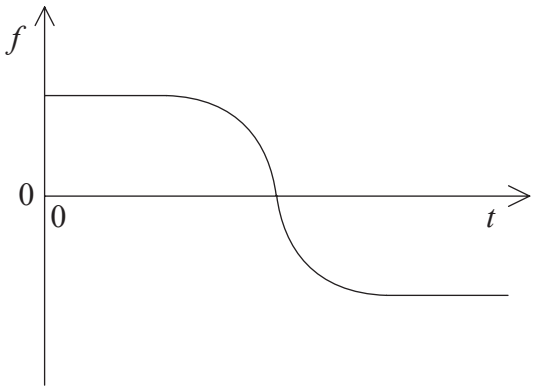
D. $\lambda = 2(y - x)$

17. A source S, moving at constant speed, emits a sound of constant frequency. The source passes by a stationary observer O, as shown below.

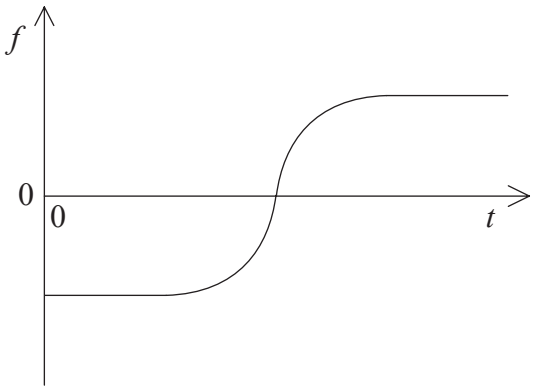


Which of the following shows the variation with time t of the frequency f observed at O as the source S approaches and passes by the observer?

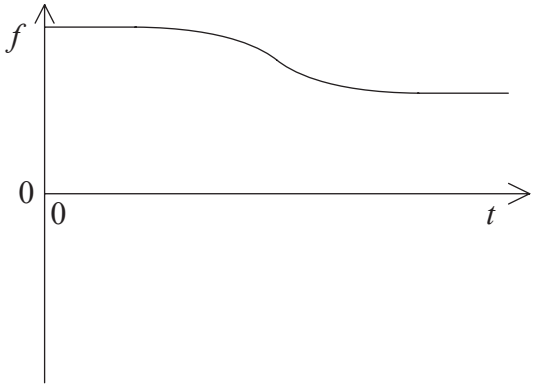
A.



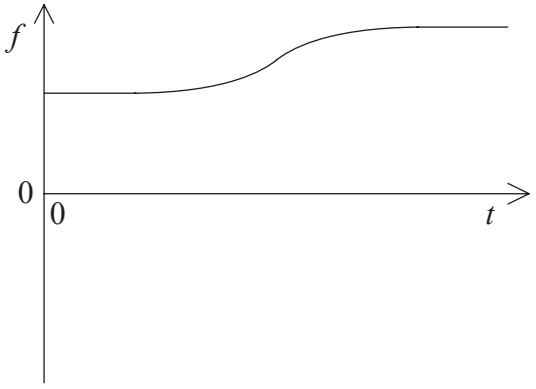
B.



C.

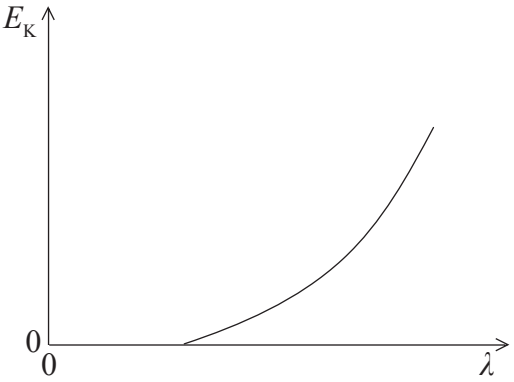


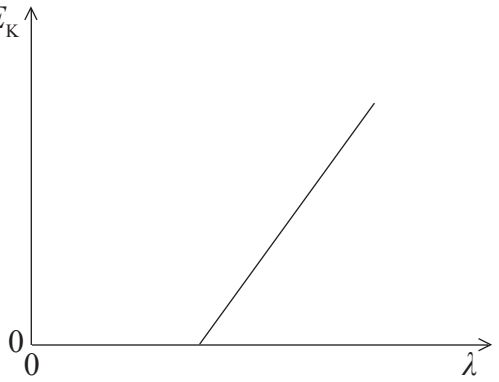
D.

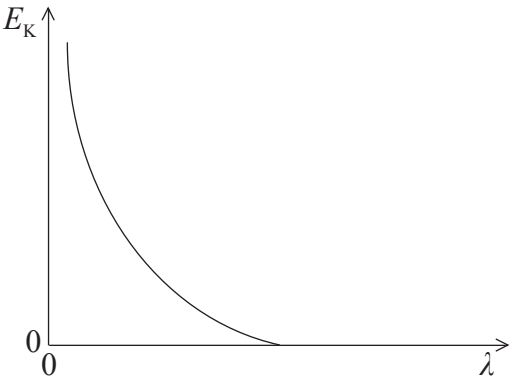


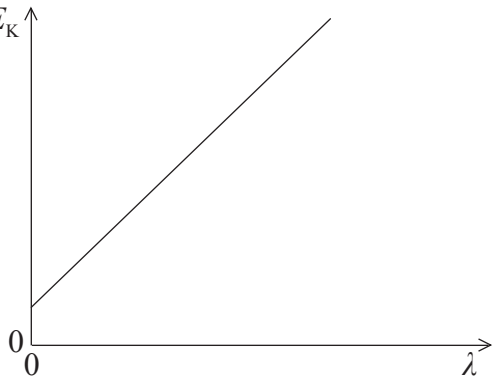
28. Light of wavelength λ is incident on a metal surface in a vacuum. Photoelectrons are emitted from the surface of the metal.

Which of the following best shows the variation with λ of the maximum kinetic energy E_K of the emitted electrons?

A.


B.


C.


D.


29. The binding energy per nucleon of the nucleus $^{7}_{3}\text{Li}$ 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.

30. 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

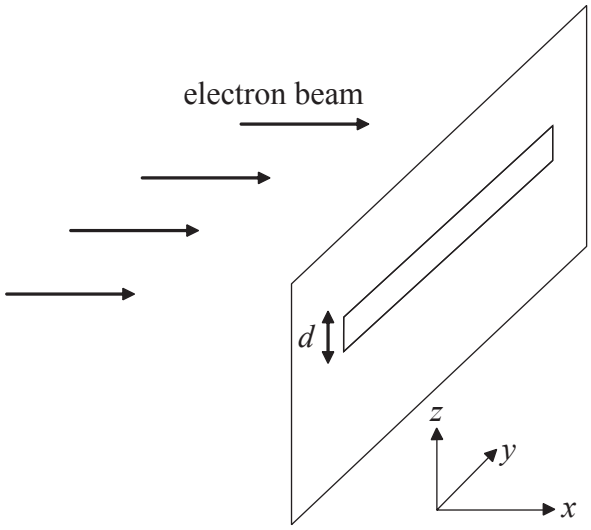
A. has a lower than 50 % chance of decaying.

B. will certainly decay.

C. has a 50 % chance of decaying.

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

31. A beam of electrons of uniquely defined wavelength λ is incident on an aperture of height d. The beam is traveling along the x direction. The height d is of the same order as λ.

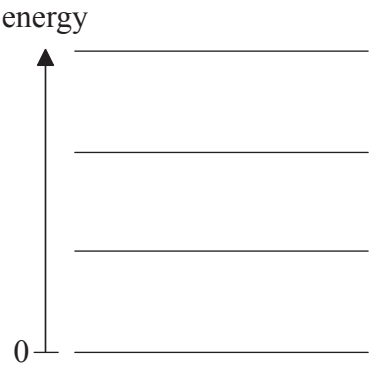


After passing through the aperture, the component of momentum in the x direction is p_x and the component in z the direction is p_z. Which of the following shows the uncertainty in p_x and the uncertainty in p_z?

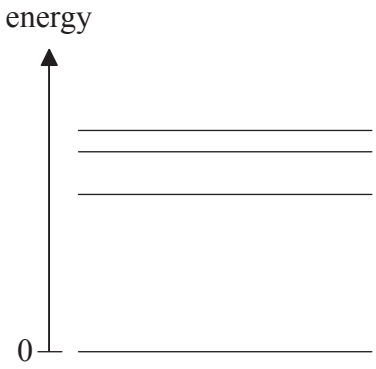
	Δp_x	Δp_z
A.	0	0
B.	0	$\frac{h}{4\pi d}$
C.	$\frac{h}{4\pi d}$	0
D.	$\frac{h}{4\pi d}$	$\frac{h}{4\pi d}$

32. A free electron is confined within a one dimensional region of fixed length. Which of the diagrams below shows the four lowest energy levels of the electron?

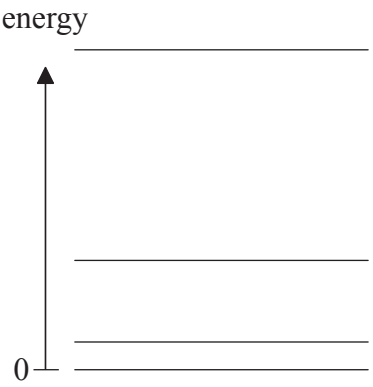
A.



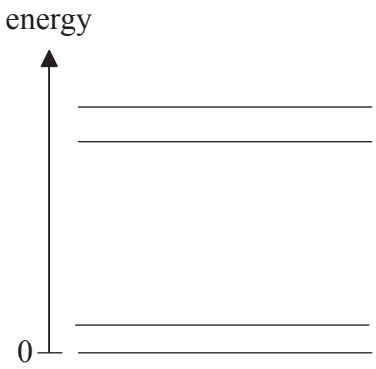
B.



C.



D.



33. Which of the following correctly describes the nature of the energy spectra of alpha (α), beta (β), and gamma (γ) radiation?

	α	**β**	**γ**
A.	discrete	continuous	discrete
B.	continuous	discrete	discrete
C.	discrete	discrete	continuous
D.	continuous	continuous	discrete

34. The volume of a given mass of water at a temperature of T_1 is V_1. The volume increases to V_2 at temperature T_2. The coefficient of volume expansion of water may be calculated from

A. $\frac{V_2}{T_2} - \frac{V_1}{T_1}$.

B. $\frac{V_2 - V_1}{T_2 - T_1}$.

C. $\frac{V_2 - V_1}{V_1(T_2 - T_1)}$.

D. $\frac{V_2 - V_1}{V_2(T_2 - T_1)}$.

35. A wind generator produces 5.0 kW of power for a wind speed of $6.0\,\text{m s}^{-1}$. The best estimate for the power produced for a wind speed of $12.0\,\text{m s}^{-1}$ is

A. 10 kW.

B. 25 kW.

C. 40 kW.

D. 125 kW.

36. It is hypothesized that global warming may lead to significant changes in the average sea-level. This hypothesis assumes that

A. average rainfall will increase.

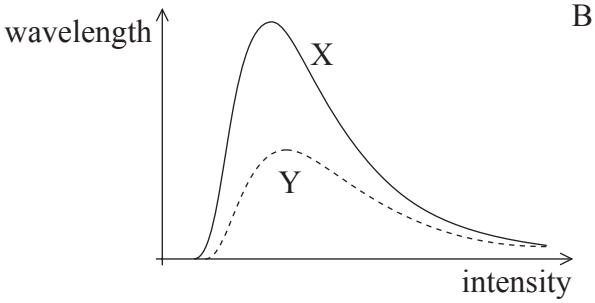
B. icebergs will melt.

C. glaciers will melt.

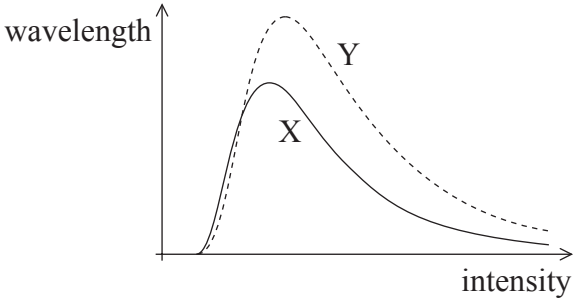
D. the rate of evaporation of seawater will increase.

37. Two black bodies X and Y are at different temperatures. The temperature of body Y is higher than that of body X. Which of the following shows the black body spectra for the two bodies?

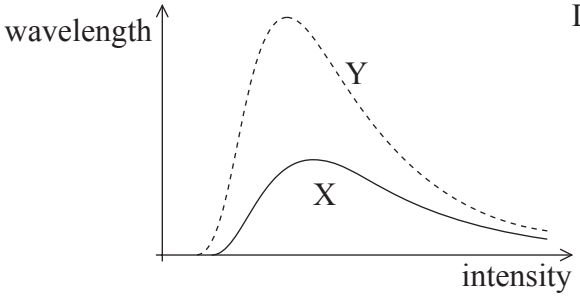
A.



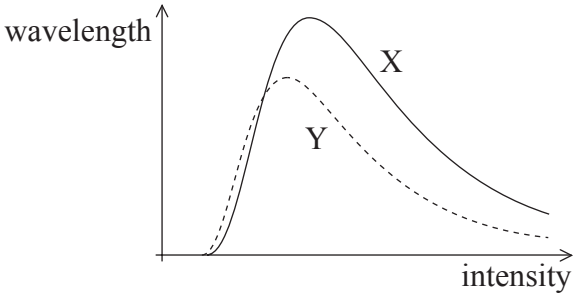
B.



C.



D.



38. The binary equivalent of the number 12 is

A. 1010.

B. 1100.

C. 0011.

D. 0101.

39. The depth of a "pit" on a CD is 150 nm. The wavelength of the laser used to read the information on the CD must be

A. 600 nm.

B. 450 nm.

C. 300 nm.

D. 150 nm.

40. The amount of charge that builds on a pixel in a charged coupled device (CCD) is proportional to which property of the incident light?

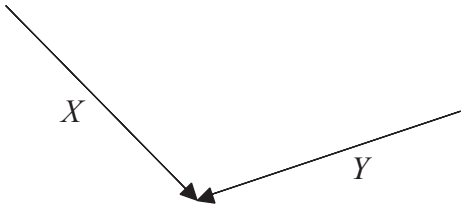
A Intensity

B. Wavelength

C. Frequency

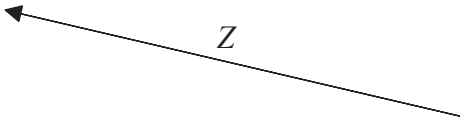
D. Amplitude

3. The diagram below shows two vectors X and Y.

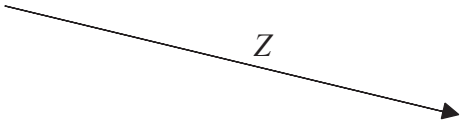


Which of the following best represents the vector $Z = X - Y$?

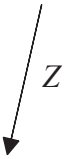
A.



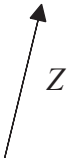
B.



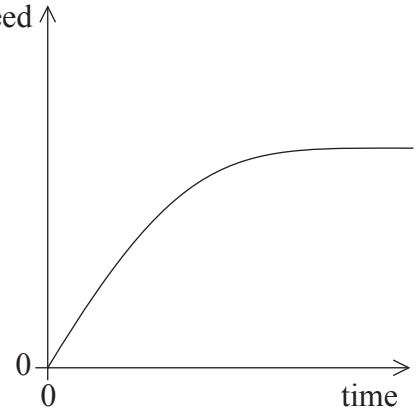
C.

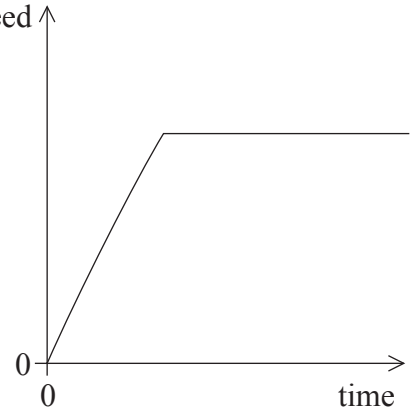


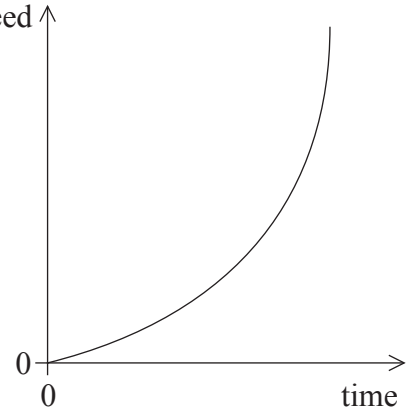
D.

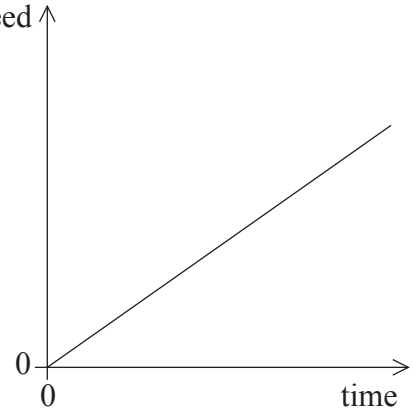


5. A steel sphere is dropped from rest in oil. Which of the following graphs best represents the variation with time of the speed of the sphere?

A.


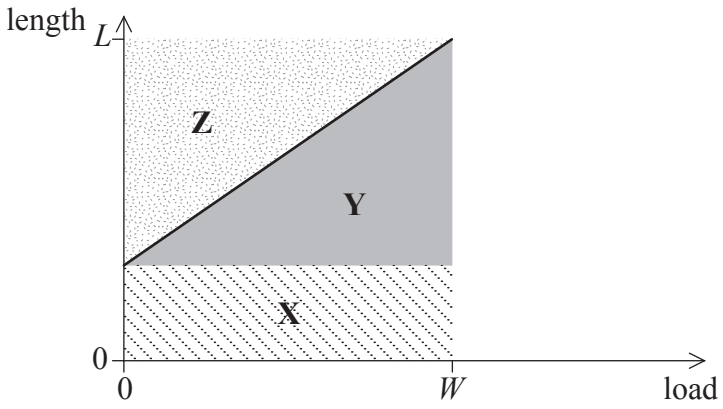
B.


C.


D.


Questions 7 and 8 both refer to the following information and graph.

The graph below shows the variation with load of the length of a spring.



For a load W the length of the spring is L.

7. Which of the following areas on the graph represents the energy stored in the spring when it is stretched to a length L?

A. X

B. Y – X

C. Z

D. X + Y

8. The spring constant of the spring is given by

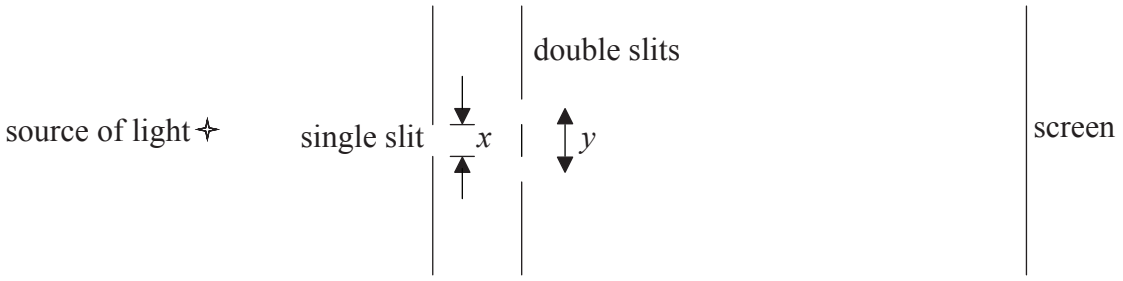
A. the gradient of the graph.

B. $\frac{1}{\text{gradient of the graph}}$.

C. $\frac{W}{L}$.

D. $\frac{L}{W}$.

24. The diagram below shows an apparatus to demonstrate the interference of light.



The width of the single slit is x and the separation of the double slits is y. Which of the following changes to the apparatus will increase the spacing of the fringes?

	x	***y***
A.	unchanged	increase
B.	increase	unchanged
C.	unchanged	decreased
D.	decrease	unchanged

26. Two sources of sound are heard simultaneously. Beats are heard when

A. the sources are coherent.

B. the sources are stationary.

C. the amplitudes of the emitted sounds are equal.

D. the frequencies of the emitted sounds are slightly different.

27. Which of the following is a unit for electrical resistance?

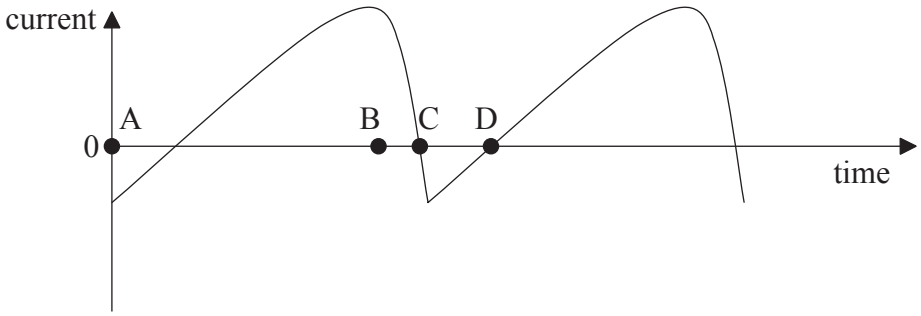
A. $\mathrm{W\,A^{-2}}$

B. $\mathrm{A\,V^{-1}}$

C. $\mathrm{V\,W^{-2}\,s}$

D. $\mathrm{W\,V^{-2}}$

33. The variation with time of the current in the primary coil of an ideal transformer is shown below.



At which time will the magnitude of the induced e.m.f. in the secondary coil be maximum?

A. A

B. B

C. C

D. D

35. Radioactive element P has a half-life of 30 days and element Q has a half-life of 20 days. Initially a radioactive source contains equal numbers of each element.

What is the ratio $\frac{\text{number of atoms of P}}{\text{number of atoms of Q}}$ after 60 days have elapsed?

A. $\frac{1}{2}$

B. $\frac{2}{3}$

C. $\frac{3}{2}$

D. 2

36. Monochromatic light is incident on a metal surface in a photocell. Which of the following statements is correct?

A. The rate at which electrons are emitted from the surface is proportional to the intensity of the radiation.

B. The rate at which electrons are emitted from the surface depends only on the frequency of the radiation used.

C. The intensity of the radiation used must be greater than a threshold value in order to emit electrons.

D. The wavelength of the radiation must be greater than a threshold value in order to emit electrons.

37. Which of the following is the correct relationship between the kinetic energy E_k of a particle and its associated de Broglie wavelength λ?

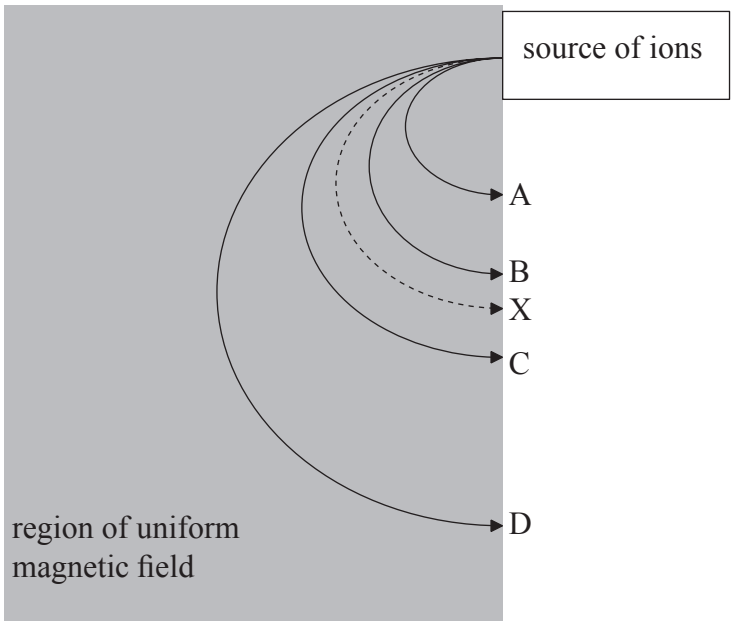
A. $\lambda \propto E_k$

B. $\lambda \propto \frac{1}{E_k^{\,2}}$

C. $\lambda \propto \frac{1}{E_k}$

D. $\lambda \propto \frac{1}{\sqrt{E_k}}$

38. The diagram below shows the deflection chamber of a mass spectrometer.



Track X shows the path of a singly-charged carbon-12 ion in the chamber.

Which track best shows the track of a singly-charged C-14 ion that has the same initial speed?

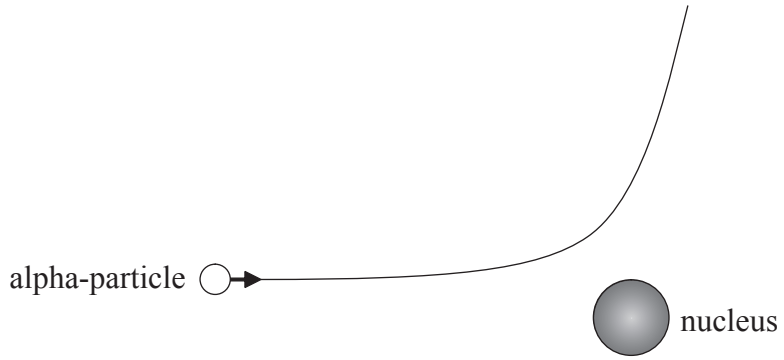
A. A

B. B

C. C

D. D

39. The diagram below shows the path followed by an alpha-particle in the vicinity of the nucleus of a gold atom.



Which of the following is correct for the alpha-particle?

A. The force acting on it changes direction.

B. The force acting on it is smaller than that acting on the nucleus.

C. Its potential energy is constant.

D. Its kinetic energy is constant.

40. Which of the following interactions is responsible for β^+-decay?

A. Electromagnetic

B. Gravitational

C. Strong

D. Weak