IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

M05/4/PHYSI/HPM/ENG/TZ1/XX+

22056507

PHYSICS
HIGHER LEVEL
PAPER 1

Thursday 19 May 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 order of magnitude of the weight of an apple is

A. 10^{-4} N.

B. 10^{-2} N.

C. 1 N.

D. 10^{2} N.

2. The reading of a constant potential difference is made four times by a student. The readings are

1.176 V
1.178 V
1.177 V
1.176 V.

The student averages these readings but does not take into account the zero error on the voltmeter.

The average measurement of the potential difference is

A. precise and accurate.

B. precise but not accurate.

C. accurate but not precise.

D. not accurate and not precise.

3. An object of mass m is hung from a spring. When the object is pulled downwards and then released, the frequency f of oscillation of the object is given by the expression

$$\frac{1}{f} = 2\pi\sqrt{\frac{m}{k}}$$

where k is a constant.

Which **one** of the following graphs would produce a straight-line for the variation with mass m of frequency f?

	***x*-axis**	***y*-axis**
A.	m	f
B.	$\sqrt{m}$	$\frac{1}{f}$
C.	$\frac{1}{m^2}$	$\frac{1}{f}$
D.	m	f^2

4. 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	± 7 %
h	± 3 %

The approximate uncertainty in r is

A. 10 %.

B. 5 %.

C. 4 %.

D. 2 %.

5. Which **one** of the following is a correct definition of *displacement*?

A. Distance from a fixed point

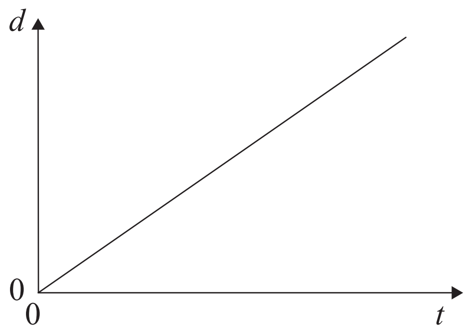
B. Distance moved from a fixed point

C. Distance from a fixed point in a given direction

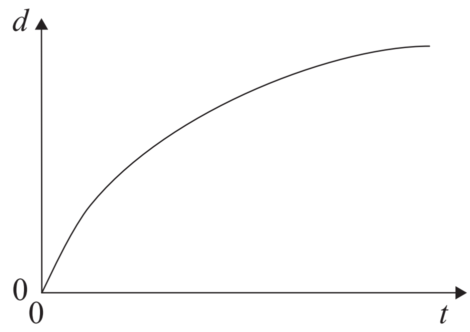
D. Distance moved in a given direction

6. A ball is held at rest in air. The ball is then released. Which **one** of the following graphs best shows the variation with time t of the distance d fallen by the ball?

A.



B.



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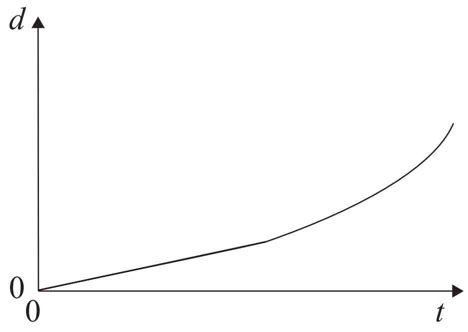
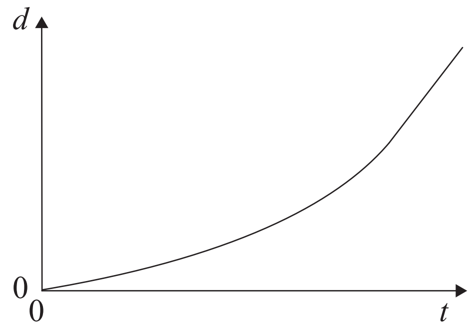
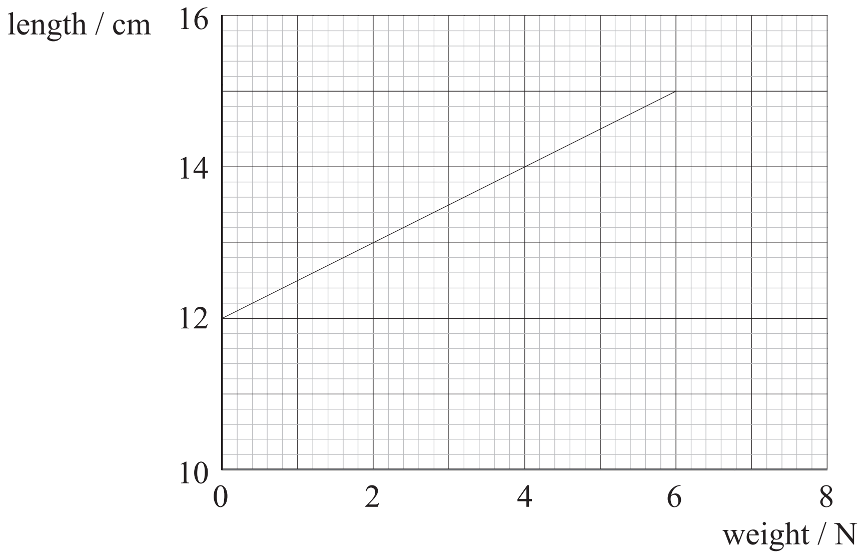


D.



7. A weight is suspended from a spring. The variation with weight of the length of the spring is shown below.



What is the value of the spring constant (force constant) of the spring?

A. $0.4\ \text{N cm}^{-1}$

B. $0.5\ \text{N cm}^{-1}$

C. $2.0\ \text{N cm}^{-1}$

D. $2.5\ \text{N cm}^{-1}$

8. A general expression for Newton's second law of motion is

$$F = \frac{\Delta p}{\Delta t}.$$

What condition is applied so that the law may be expressed in the form $F = ma$?

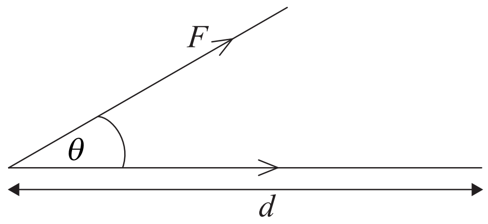
A. The mass m is constant.

B. The acceleration a is constant.

C. The force F is constant.

D. The direction of the force F is constant.

9. The point of action of a constant force F is displaced a distance d. The angle between the force and the direction of the displacement is θ, as shown below.



Which **one** of the following is the correct expression for the work done by the force?

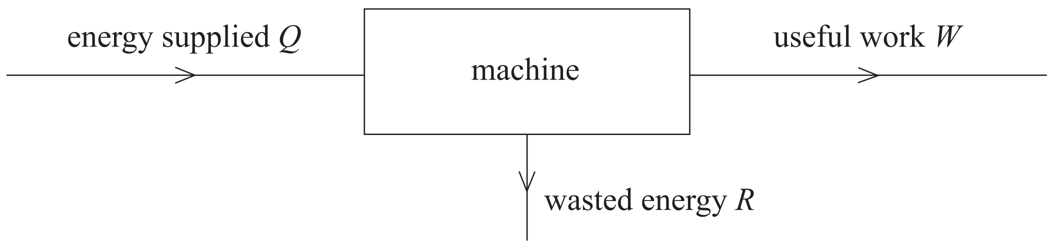
A. Fd

B. $Fd\ \sin\theta$

C. $Fd\ \cos\theta$

D. $Fd\ \tan\theta$

10. An amount Q of energy is supplied to a machine. The machine does useful work W and an amount R of energy is wasted, as illustrated below.



Which **one** of the following is a correct expression for the efficiency of the machine?

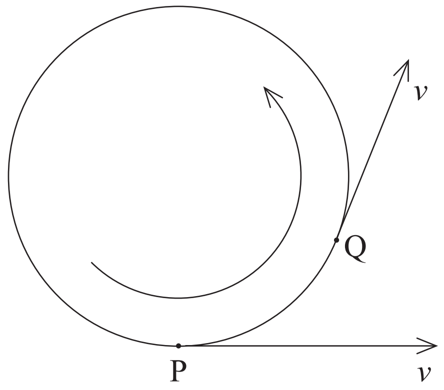
A. $\dfrac{W}{Q}$

B. $\dfrac{R}{Q}$

C. $\dfrac{W+R}{Q}$

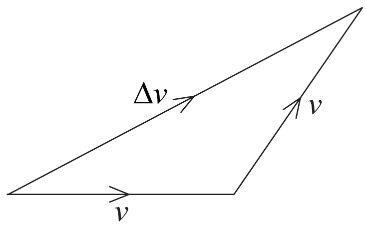
D. $\dfrac{W-R}{Q}$

11. A point mass is moving in a horizontal circle with a velocity of constant magnitude v. At one particular time, the mass is at P. A short time later, the mass is at Q, as shown below.

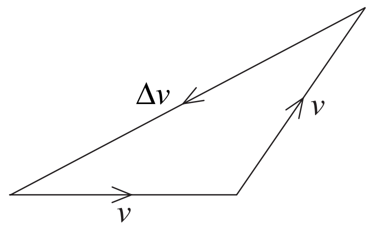


Which vector diagram correctly shows the change in velocity Δv of the mass during this time?

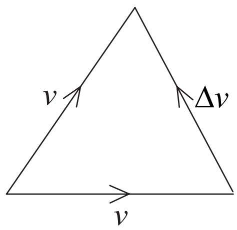
A.



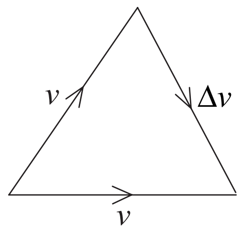
B.



C.



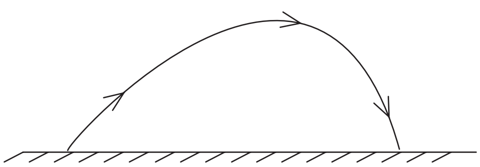
D.



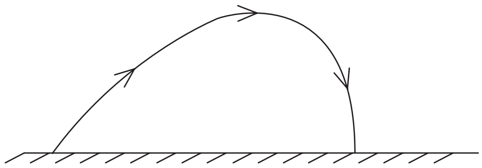
12. A boy throws a small stone at an angle to the horizontal.

Which **one** of the following sketches best shows the path of the stone as it rises and then falls back to Earth? Air resistance is negligible and the acceleration of free fall is constant.

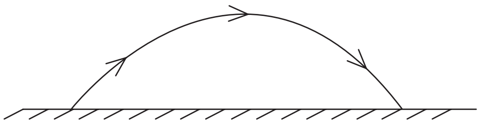
A.



B.



C.



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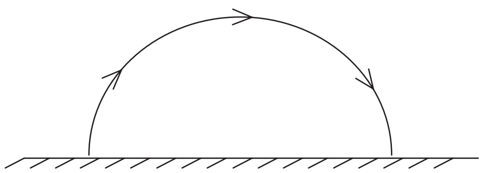


13. Newton's law of gravitation for the force F between two point objects of masses M and m, separated by a distance d may be written as

$$Fd^2 \propto Mm\,.$$

The expression may also be used for the force of attraction between the Sun and the Earth, although they are not point masses. This is because

A. the gravitational constant G is not involved in the expression.

B. the force between the Sun and the Earth is very large.

C. the separation of the Sun and the Earth is much greater than their radii.

D. the mass of the Earth is much less than the mass of the Sun.

14. An isolated point object has mass M. A second small point object of mass m is placed a distance x from the larger mass.

Which **one** of the following is a correct expression for the gravitational potential energy of the mass m?

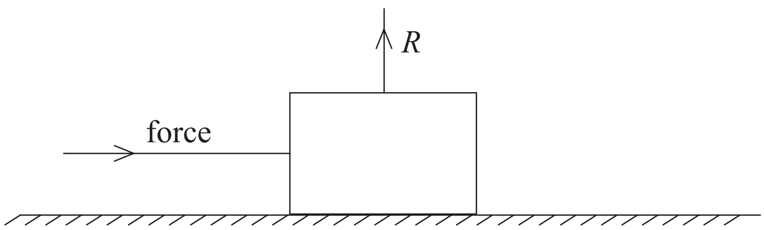
A. $-\frac{GM}{x}$

B. $-\frac{GMm}{x}$

C. $-\frac{GM}{x^2}$

D. $-\frac{GMm}{x^2}$

15. A block rests on a flat surface. The normal reaction of the surface on the block is R. A horizontal force is applied to the block that gradually increases in magnitude from zero.

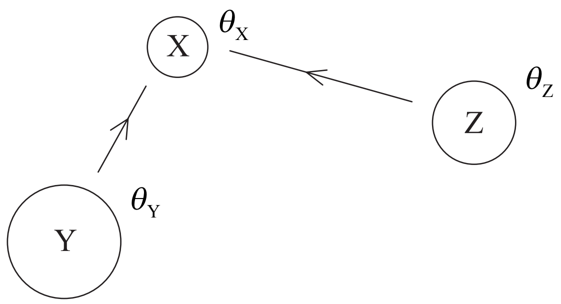


The coefficients of static friction and of dynamic friction between the block and the surface are μ_S and μ_D respectively.

Which **one** of the following gives the possible values for the static and the dynamic friction forces between the block and the surface?

	Static friction force	Dynamic friction force
A.	$0 \rightarrow \mu_S R$	$\mu_D R$
B.	$0 \rightarrow \mu_S R$	$0 \rightarrow \mu_D R$
C.	$\mu_S R$	$\mu_D R$
D.	$\mu_S R$	$0 \rightarrow \mu_D R$

16. Three bodies X, Y and Z are at temperatures θ_X, θ_Y and θ_Z respectively. Thermal energy passes freely from Y to X and also from Z to X, as illustrated below.



The direction of flow of thermal energy, if any, between Y and Z is unknown.

What can de deduced about the temperatures θ_X, θ_Y and θ_Z ?

A. $\theta_X = (\theta_Y + \theta_Z)$

B. $\theta_Y = \theta_Z$

C. $\theta_Y > \theta_X$

D. $\theta_X > \theta_Z$

17. A liquid is evaporating, causing the liquid to cool.

The temperature of the liquid decreases because

A. the number of liquid molecules is decreasing.

B. the mean kinetic energy of the liquid molecules is decreasing.

C. the pressure above the liquid surface is increasing.

D. the rate of evaporation is increasing.

18. The equation of state of an ideal gas is

$$pV = nRT.$$

In this equation, the constant n is the number of

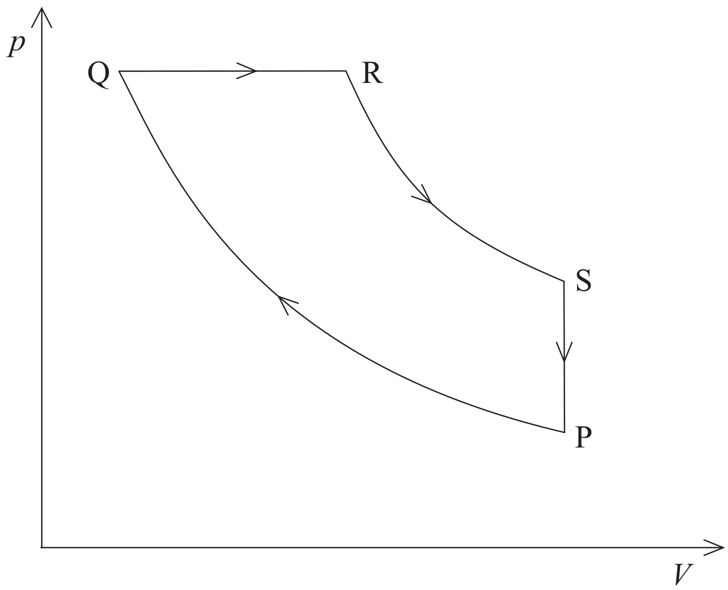
A. atoms in the gas.

B. molecules in the gas.

C. particles in the gas.

D. moles of the gas.

19. The diagram shows the pressure / volume (p/V) diagram for one cycle PQRS of an engine.



In which sections of the cycle is work done **on** the engine?

A. SP only

B. PQ only

C. SP and PQ only

D. RS and SP only

20. A Carnot engine operates between two thermal reservoirs. The thermodynamic temperature of the higher-temperature reservoir is T_H and of the lower, T_L .

Which **one** of the following is a correct expression for the efficiency of the engine?

A. $\frac{T_H}{T_L}$

B. $\frac{T_L}{T_H}$

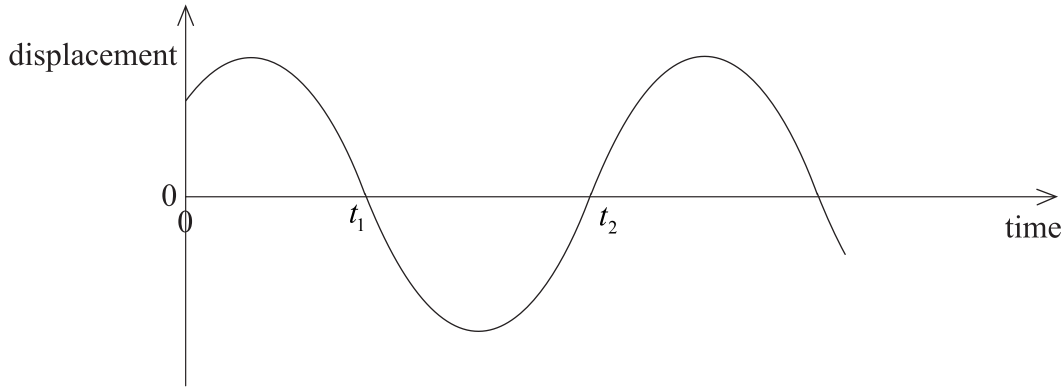
C. $1-\left(\frac{T_H}{T_L}\right)$

D. $1-\left(\frac{T_L}{T_H}\right)$

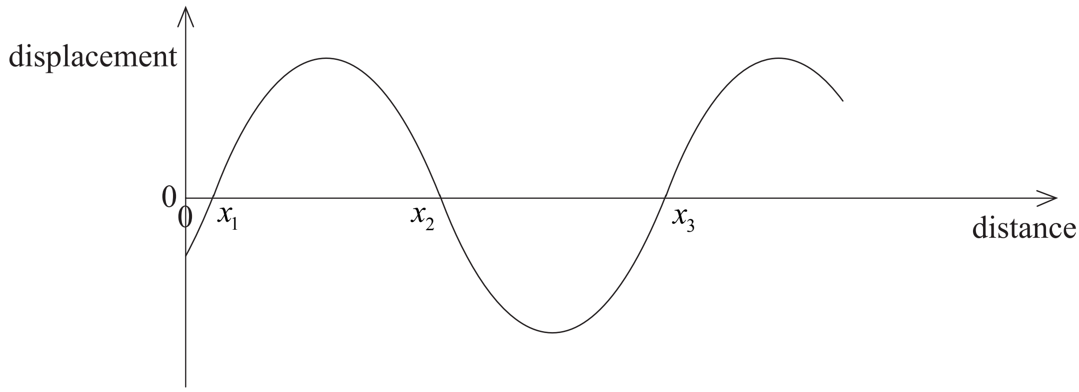
21. Graph P shows how the displacement at one point in a wave varies with time.

Graph Q shows how the displacement in the same wave varies with distance along the wave at one particular time.

Graph P



Graph Q



Which **one** of the following expressions gives the speed of the wave?

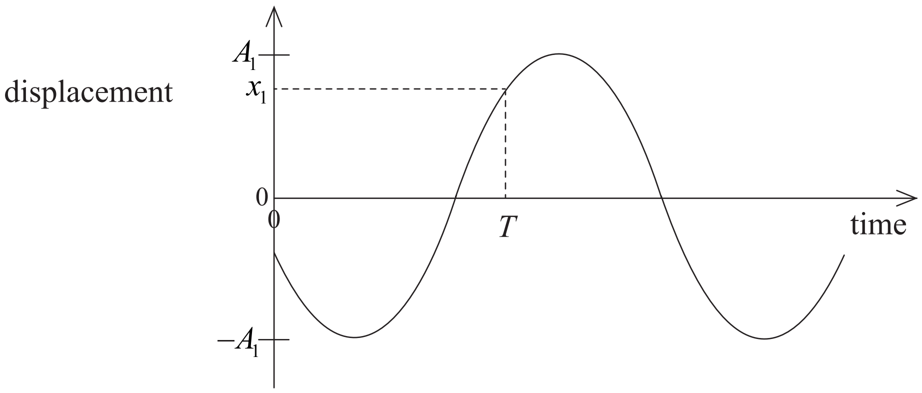
A. $\dfrac{x_1}{t_1}$

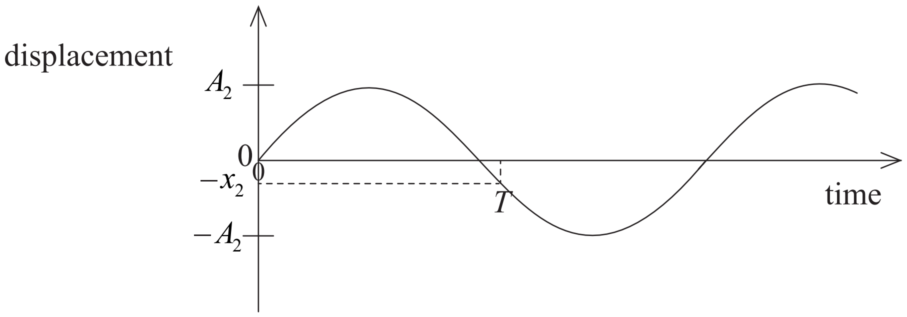
B. $\dfrac{x_2}{t_2}$

C. $\dfrac{(x_2 - x_1)}{(t_2 - t_1)}$

D. $\dfrac{(x_3 - x_1)}{(t_2 - t_1)}$

22. 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

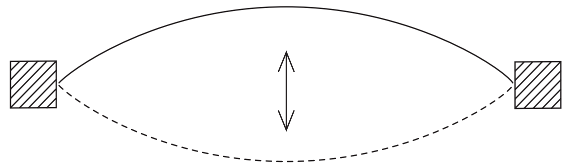
A. $x_1 + x_2$.

B. $x_1 - x_2$.

C. $A_1 + A_2$.

D. $A_1 - A_2$.

23. A string is stretched between two fixed points. The string is plucked at its centre and is seen to vibrate with frequency f as shown below.



Which **one** of the following expressions gives the frequencies of other possible modes of vibration that have an antinode at the centre? The number n in each expression is an integer.

A. nf

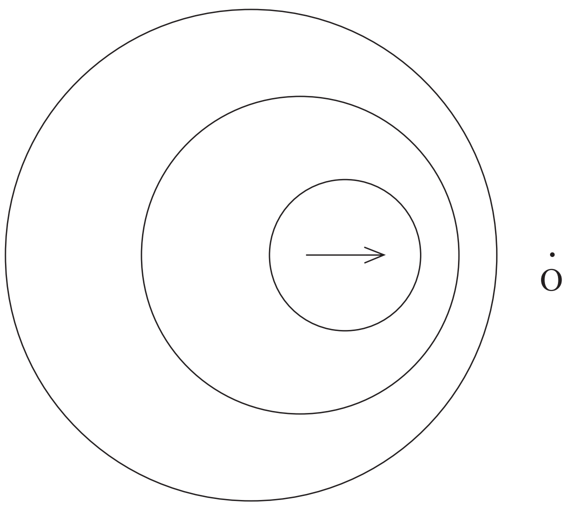
B. $(2n-1)f$

C. $(n-1)f$

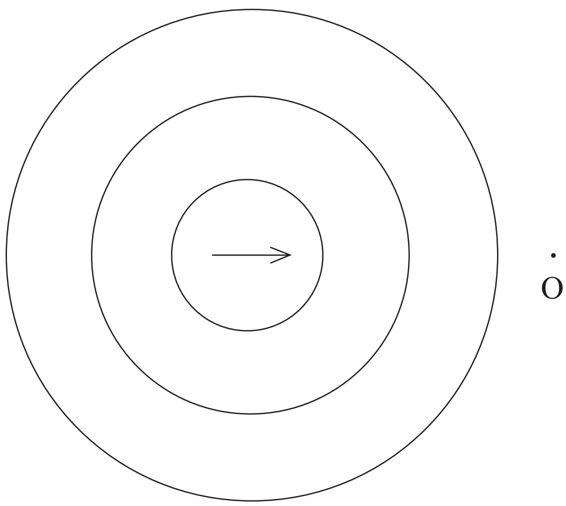
D. $(n+1)f$

24. Which **one** of the following diagrams best represents wavefronts produced by a source of sound of constant frequency as it moves at constant speed towards a stationary observer at O?

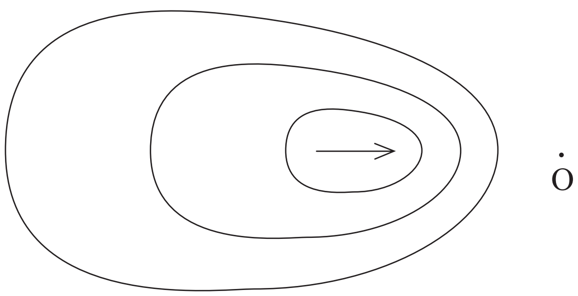
A.



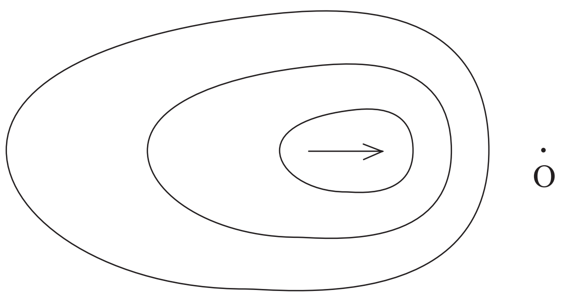
B.



C.



D.



25. The waves from two light sources meet at a point. Which condition is essential for interference to be observed?

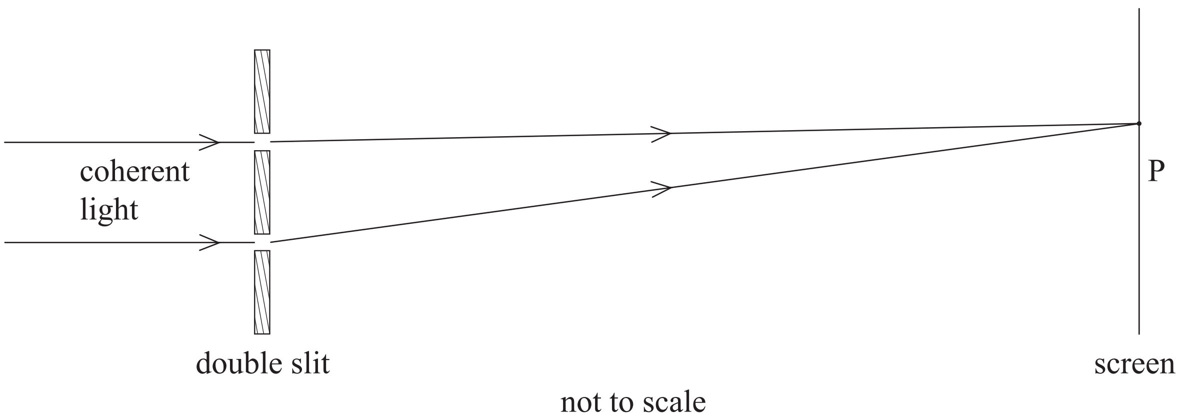
A. Constant phase difference between the waves

B. Equal amplitude of the waves

C. Equal frequency of the waves

D. Equal intensities of the waves

26. Light from a double slit arrangement produces bright and dark fringes on a screen in the region near point P, as indicated below.

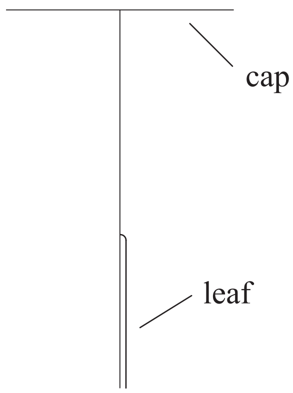


The light from the two slits has equal amplitudes on reaching point P.

Which **one** of the following gives the change, if any, in the appearance of the bright and the dark fringes when the amplitude of the light wave from one slit is reduced?

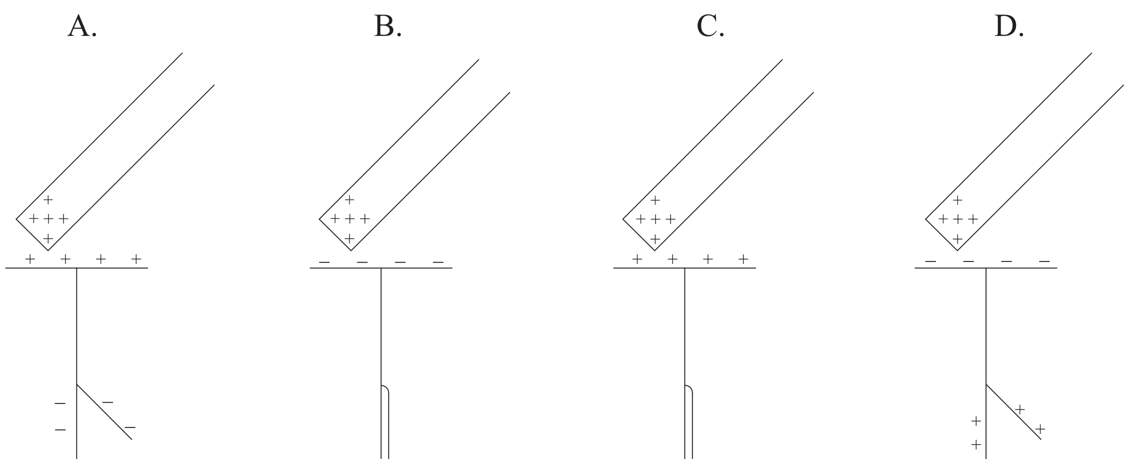
	Bright fringes	**Dark fringes**
A.	Remains the same	Remains the same
B.	Becomes less bright	Remains the same
C.	Becomes less bright	Becomes more bright
D.	Remains the same	Becomes more bright

27. The leaf and cap of an uncharged gold-leaf electroscope are shown below.



A positively charged rod is brought near to the cap of the electroscope.

Which diagram best shows the distribution of charge on the electroscope?



28. The electric field strength at a point may be defined as

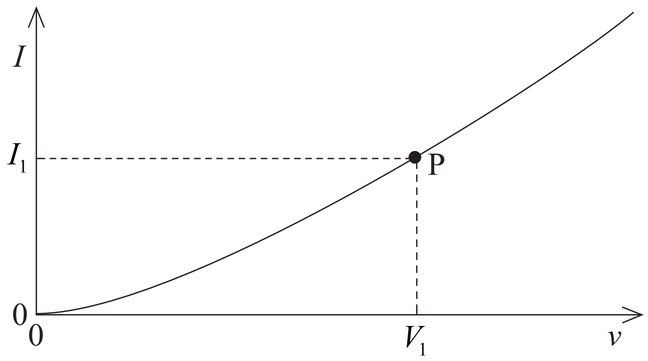
A. the force exerted on unit positive charge placed at that point.

B. the force per unit positive charge on a small test charge placed at that point.

C. the work done on unit positive charge to move the charge to that point from infinity.

D. the work done per unit positive charge to move a small test charge to that point from infinity.

29. The graph shows the variation with applied potential difference V of the current I in an electrical component.



Which **one** of the following gives the resistance of the component at point P?

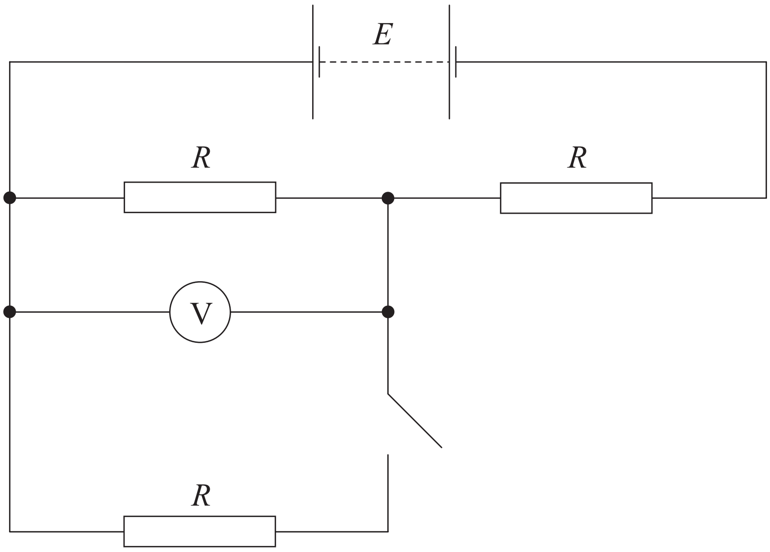
A. The gradient of the line at P

B. The reciprocal of the gradient of the line at P

C. The ratio $\frac{I_1}{V_1}$

D. The ratio $\frac{V_1}{I_1}$

30. A battery of e.m.f. *E* and negligible internal resistance is connected to three resistors, each of resistance *R*, a voltmeter and a switch, as shown below.



The voltmeter has infinite resistance.

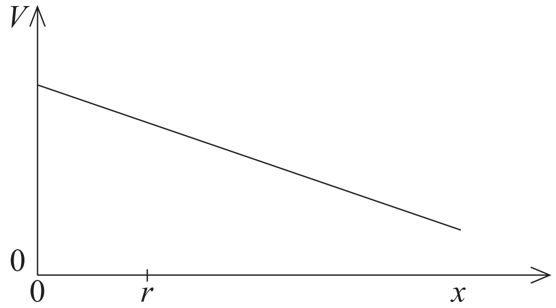
What are the readings on the voltmeter when the switch is open and when it is closed?

	Switch open	Switch closed
A.	0	less than ½ *E*
B.	0	½ *E*
C.	½ *E*	less than ½ *E*
D.	½ *E*	½ *E*

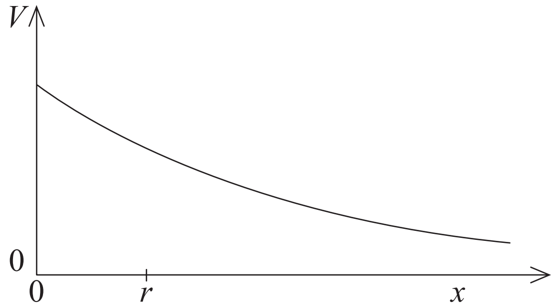
31. An isolated *conducting* sphere of radius r is positively charged.

Which **one** of the following graphs best shows the variation with distance x from the centre of the sphere of the electric potential V?

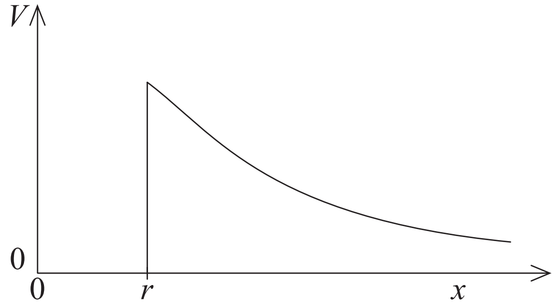
A.



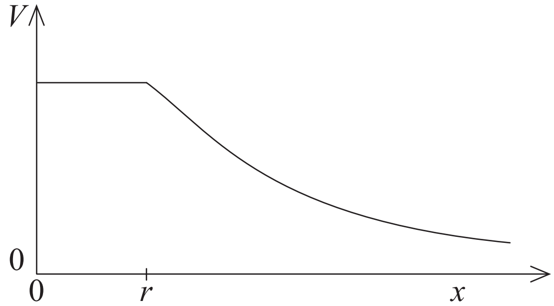
B.



C.



D.



32. Faraday's law of electromagnetic induction states that the induced e.m.f. is

A. proportional to the change in magnetic flux linkage.

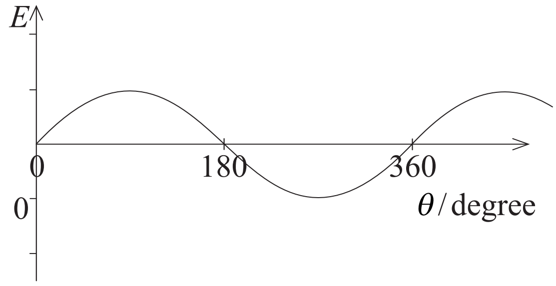
B. proportional to the rate of change of magnetic flux linkage.

C. equal to the change in magnetic flux linkage.

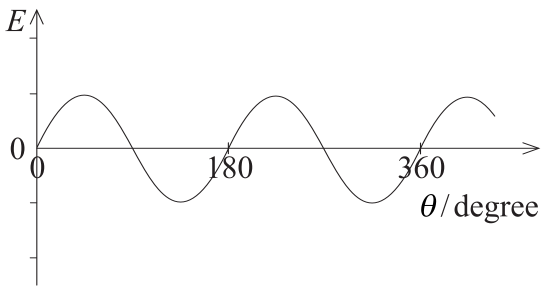
D. equal to the change of magnetic flux.

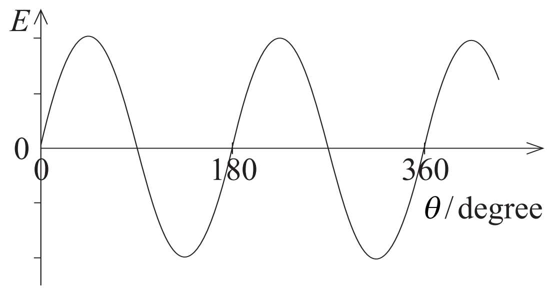
33. A coil rotates at a constant rate in a uniform magnetic field. The angle of rotation of the coil from its starting position is θ.

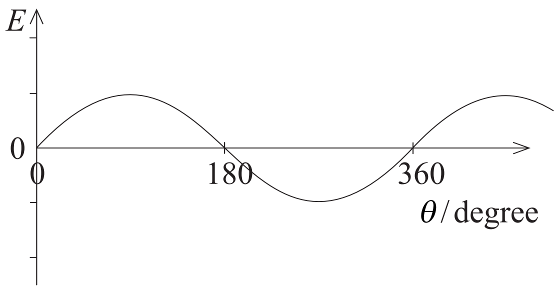
The variation with angle θ of the e.m.f. E generated in the coil is shown below.

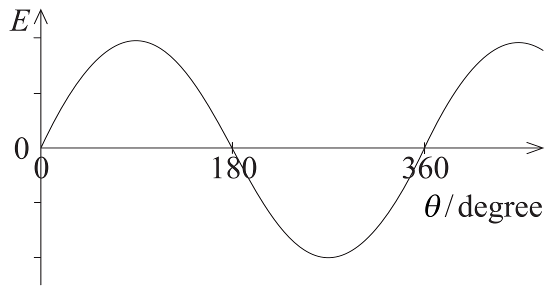


Which **one** of the following graphs best shows the variation with θ from the starting position of the e.m.f. E when the rate of rotation of the coil is doubled?

A. 

B. 

C. 

D. 

34. The number of nucleons in a nucleus is the number of

A. particles in the nucleus.

B. neutrons in the nucleus.

C. protons in the nucleus.

D. protons plus neutrons in the nucleus.

35. Radioactive decay is a *random* process. This means that

A. a radioactive sample will decay continuously.

B. some nuclei will decay faster than others.

C. it cannot be predicted how much energy will be released.

D. it cannot be predicted when a particular nucleus will decay.

36. A freshly-prepared sample of cobalt-64 $({}^{64}_{27}\mathrm{Co})$ decays by the emission of γ-ray photons. The decay may be represented by the nuclear equation

$${}^{64}_{27}\mathrm{Co} \rightarrow {}^{64}_{27}\mathrm{Co} + \text{energy}.$$

After this decay, the binding energy per nucleon has

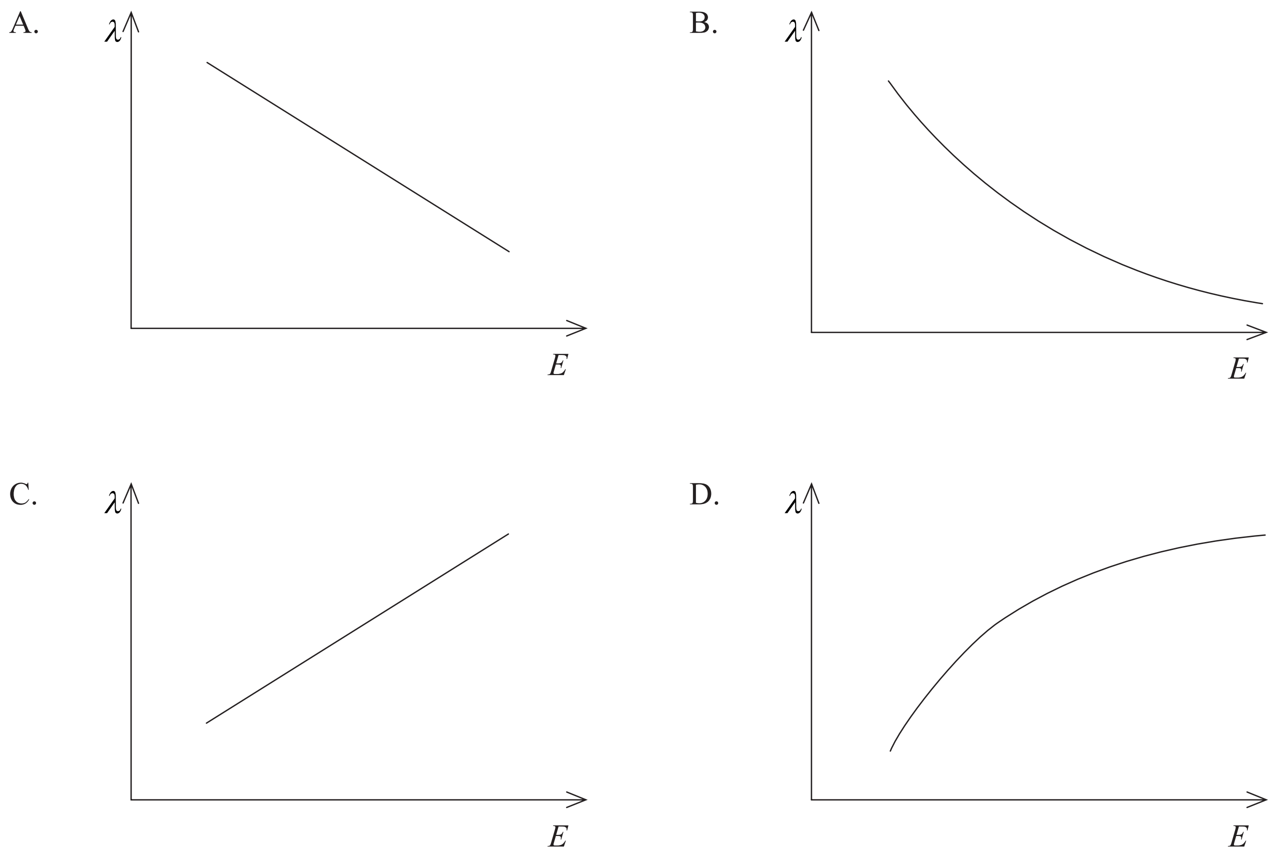
A. increased in magnitude because energy has been emitted from the nucleus.

B. decreased in magnitude because energy has been emitted from the nucleus.

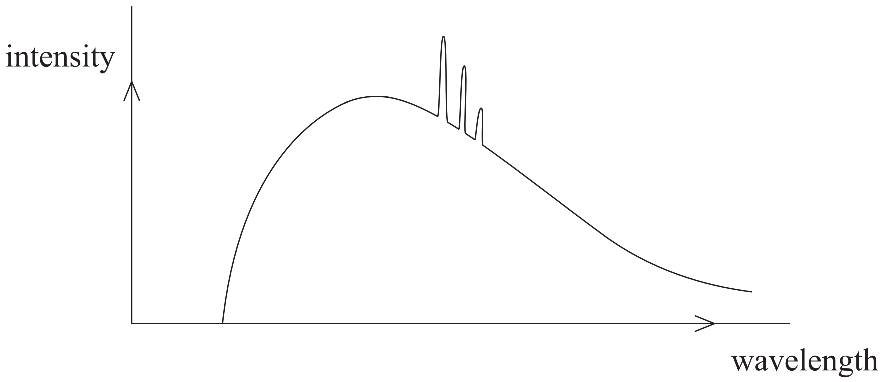
C. stayed constant because the number of nucleons in the nucleus is unchanged.

D. stayed constant because the proton number is unchanged.

37. Which **one** of the following best shows the variation with kinetic energy E of the de Broglie wavelength λ associated with a particle?



38. The graph below shows a spectrum of X-ray radiation produced when high-speed electrons are incident on a metal target.



The peaks in the spectrum come about as a result of

A. excitation of electrons in the metal target.

B. de-excitation of electrons in the metal target.

C. excitation of electrons incident on the metal target.

D. de-excitation of electrons incident on the metal target.

39. The decay constant λ in radioactive decay is defined as

A. the probability of decay per unit time of a nucleus.

B. the probability of decay of a nucleus.

C. the constant $\left(\frac{\ln 2}{T_{\frac{1}{2}}}\right)$ where $T_{\frac{1}{2}}$ is the half-life.

D. the constant in the radioactive decay equation $N = N_0 e^{-\lambda t}$.

40. The spectrum of energy of β^--particles emitted in radioactive decay is explained on the basis of

A. the emission of neutrinos during the decay process.

B. the emission of antineutrinos during the decay process.

C. the absorption of neutrinos during the decay process.

D. the absorption of antineutrinos during the decay process.