IB · DP · Physics

40 mins 40 questions

# Practice Paper 1

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**Total Marks** /40

**1** A stone falls from rest to the bottom of a water well of depth $d$. The time $t$ taken to fall is 3.0 ± 0.3 s. The depth of the well is calculated to be 30 m using $d = \frac{1}{2}at^2$. The uncertainty in a is negligible.

What is the absolute uncertainty in $d$?

**A.** ± 0.6 m

**B.** ± 3 m

**C.** ± 24 m

**D.** ± 6 m

**(1 mark)**

**2** A micrometer is used to measure the diameters of two spheres.

| | |
|---|---|
| Diameter of first sphere | 15.01 ± 0.01 mm |
| Diameter of second sphere | 17.38 ± 0.02 mm |

The difference in the diameters is calculated.

What is the uncertainty in this difference?

**A.** ± 0.01 mm

**B.** ± 0.02 mm

**C.** 0.03 mm

**D.** ± 0.06 mm

**(1 mark)**

**3** On a clear day, in the absence of air resistance, a cannon ball is fired at an angle $\theta$ to the ground with an initial velocity $u$. Its horizontal range is $s$. Which of the following statements is incorrect?

**A.** The time of flight is $\frac{s}{u \cos \theta}$

**B.** The time of flight is $\frac{2u \sin \theta}{g}$ where $g$ is the acceleration of free fall

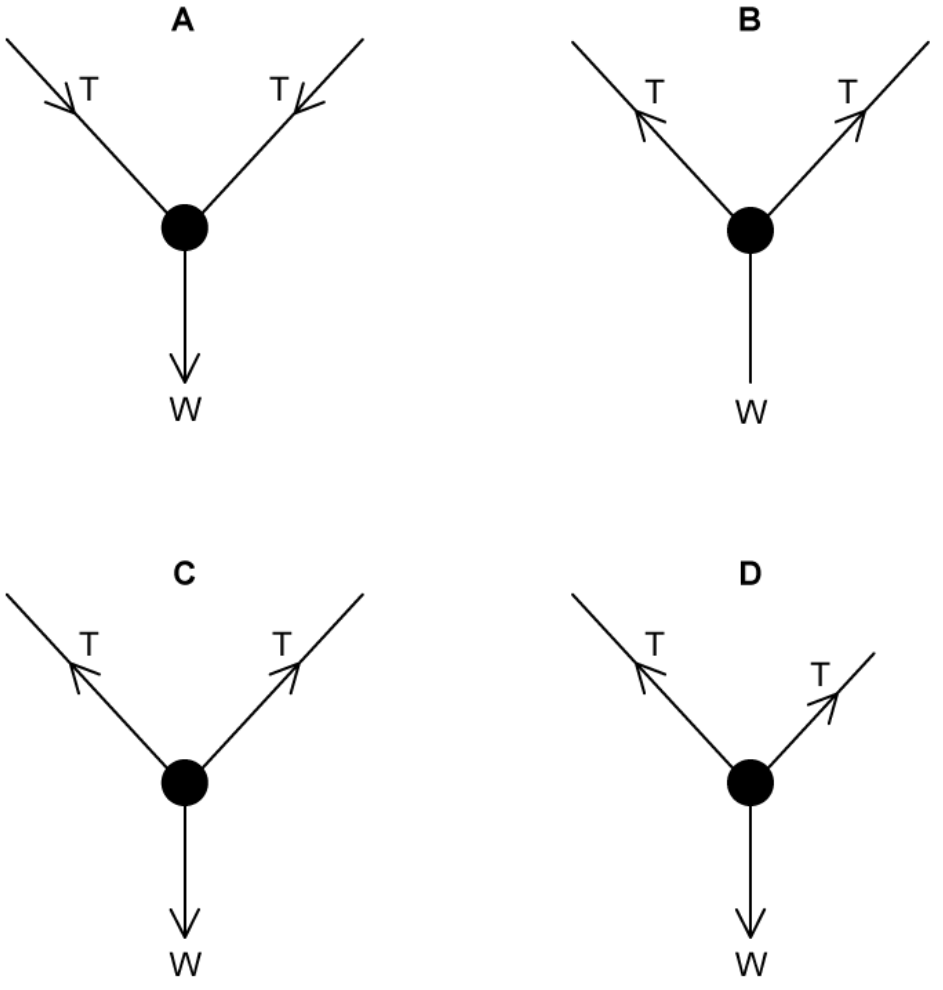
**C.** The shadow of the cannon ball moves with a constant velocity while the ball is in flight

**D.** The linear momentum of the cannon ball is constant during flight

**(1 mark)**

**4** A photo hangs from two strings. It has a weight $W$ and the two strings have equal tension $T$.

What is the free–body diagram for this situation?



**(1 mark)**

**5** An object falls from rest from a height *h* close to the surface of the Moon. The Moon has no atmosphere.

When the object has fallen to height $\frac{h}{3}$ above the surface, what is

$$\frac{gravitational\ potential\ energy\ of\ the\ object\ at\ h}{kinetic\ energy\ of\ the\ object\ at\ \frac{h}{3}}$$

**A.** 3

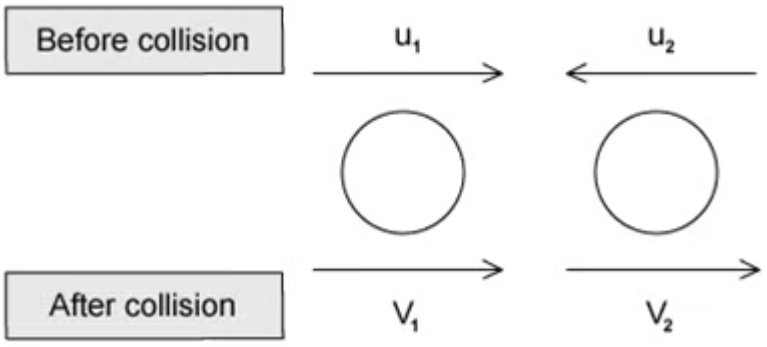
**B.** $\frac{1}{3}$

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

**D.** $\frac{3}{2}$

**(1 mark)**

**6** Two spheres approach each other along the same straight line. Their speeds are $u_1$ and $u_2$ before collision, and $v_1$ and $v_2$ after collision, in the directions shown below




Which equation is correct if the collision is perfectly elastic?

**A.** $u_1 - u_2 = v_2 - v_1$

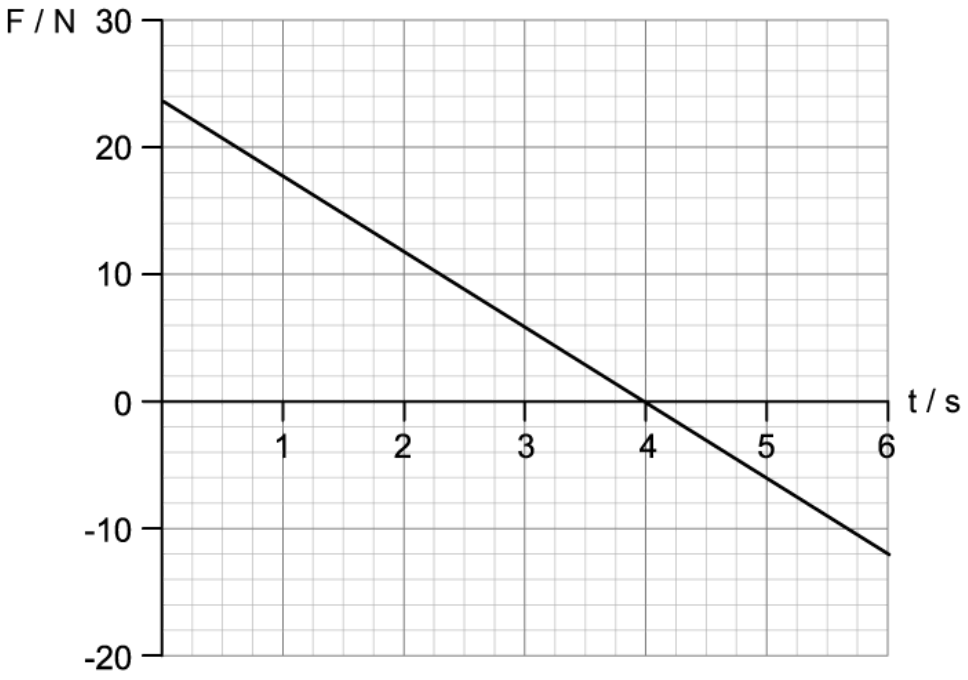
**B.** $u_1 - u_2 = v_2 + v_1$

**C.** $u_1 + u_2 = v_2 + v_1$

**D.** $u_1 + u_2 = v_2 - v_1$

**(1 mark)**

**7** A force acts on a mass of 5.0 kg and it is initially at rest.




What is the time taken for the mass to reach an acceleration of 2 m $s^{-2}$?

**A.** 2.50 s

**B.** 2.20 s

**C.** 2.25 s

**D.** 2.00 s

**(1 mark)**

**8** Which row gives the correct Newton's third law force pair for a book on a table?

| | Force A | Force B |
|---|---|---|
| **A.** | Weight of the book | Force of book on the table |
| **B.** | Gravitational force of the Earth pulling on the book | Gravitational force of the book pulling on the Earth |
| **C.** | Weight of the book | Reaction force from the table surface |
| **D.** | Gravitational force of the Earth pulling on the book | Gravitational force of the table pulling on the Earth |

**(1 mark)**

**9** A 2 kW kettle supplies energy to a water of mass 1 kg. The initial temperature of the water is 20 °C. The specific heat capacity of water can be taken to be 4000 J $kg^{-1}$ $K^{-1}$.

How long does it take for the water to start boiling?

**A.** 80 s

**B.** 120 s

**C.** 160 s

**D.** 210 s

**(1 mark)**

**10** Equipotential surfaces corresponding to lines of constant gravitational potential are conventionally drawn so that the difference in potential between any two adjacent surfaces is the same.

Consider the equipotential surfaces for a spherical mass *M*. Which of the following statements is incorrect?

**A.** Equipotential surfaces are spheres of constant radius around *M*

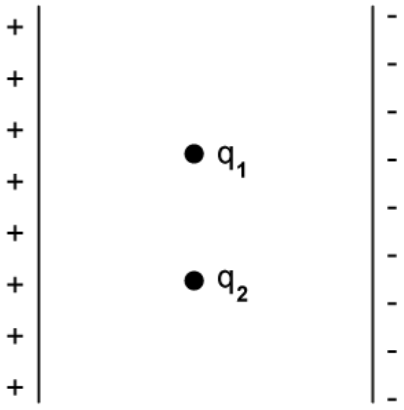
**B.** The distance between equipotential surfaces increases with distance from *M*

**C.** No work is done by the gravitational field of *M* if a test mass moves along an equipotential surface

**D.** The radius of each equipotential surface depends on the diameter of *M*

**(1 mark)**

**11** Two positively charged particles, $q_1$ and $q_2$, are released from rest half-way between two oppositely charged parallel plates in a vacuum. The particles strike the negatively charged plate at the same time.




Neglecting gravitational effects, which of the following statements is correct?

**A.** The particles have the same charge only

**B.** The particles have the same mass only

**C.** The particles have the same mass and charge

**D.** The particles have the same charge to mass ratio

**(1 mark)**

**12** What are the units of the ratio $\frac{specific\ latent\ heat\ of\ fusion\ of\ iron}{specific\ heat\ capacity\ of\ iron}$?

**A.** J K

**B.** No units

**C.** $K^{-1}$

**D.** K

**(1 mark)**

**13** Which statement describes a correct assumption for the kinetic model of an ideal gas?

**A.** The kinetic energy of a given molecule of the gas is constant.

**B.** The forces between each gas molecule varies.

**C.** The intermolecular potential energy of the molecules of the gas varies.

**D.** The momentum of a given molecule of the gas varies upon a collision with the container.

**(1 mark)**

**14** **X** and **Y** are two flasks containing an ideal gas that are connected by a tube that has negligible volume compared with the volume of each flask. The volume of **X** is twice the volume of **Y**.

The temperature of the gas in **X** is kept at 200 K and the temperature of the gas in **Y** is kept at 400 K.

If the mass of the gas in **X** is $M_X$ and the mass of the gas in **Y** is $M_Y$, what is the ratio $\frac{M_X}{M_Y}$?

**A.** $\frac{1}{8}$

**B.** $\frac{1}{4}$

**C.** 4

**D.** 8

**(1 mark)**

**15** Which frequency of sound wave would a human be able to hear?

**A.** 2 Hz

**B.** 200 Hz

**C.** 200 kHz

**D.** 2000 kHz

**(1 mark)**

**16** A pendulum bob is suspended by a thread. The bob is moved to the right and released so that the pendulum oscillates isochronously.

Taking motion to the left to be positive, which of the following statements is incorrect about the motion of the pendulum?

**A.** The potential energy of the system will reach its maximum value three times in one oscillation

**B.** At $\frac{T}{4}$ the kinetic energy of the system is at its maximum value and the velocity is maximum in the positive direction

**C.** At $\frac{3T}{4}$ the kinetic energy of the system is at a maximum and the velocity is at a maximum in the negative direction

**D.** At $\frac{T}{2}$, the force is acting in the negative direction and the kinetic energy is at its maximum value

**(1 mark)**

**17** A pendulum bob on a string oscillates in SHM with a frequency, *f*.

The period, *T*, of a simple pendulum is related to the length of the string, *l*, and the acceleration of free fall, *g*, by the following equation:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

What is the ratio of the new frequency to the original frequency if the length of the string is increased by a factor of 4?

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

**B.** $\frac{1}{2}$

**C.** $\sqrt{2}$

**D.** 4

**(1 mark)**

**18** Identify the pair of statements which are always true for electromagnetic waves

| | | |
|---|---|---|
| **A.** | Always travel at the same speed in a vacuum | Always obey the inverse square law |
| **B.** | Can undergo plane polarisation | Consist of electric and magnetic fields which have constant amplitude |
| **C.** | Have predictable reduction in intensity when passed through a polarising filter | Always travel at the same speed in a vacuum |
| **D.** | Consist of electric and magnetic fields which transfer energy | Are always polarised |

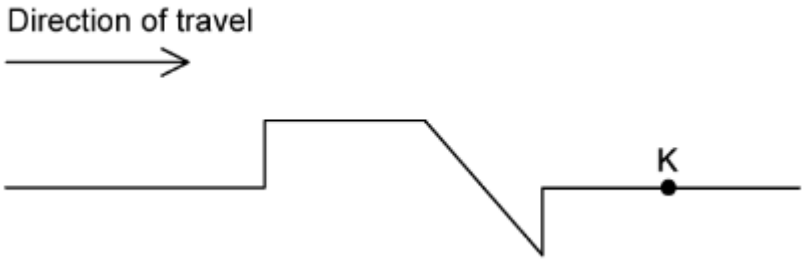
**(1 mark)**

**19** Which **one** of the following options is always true regarding the energy transferred along a standing wave and its amplitude?

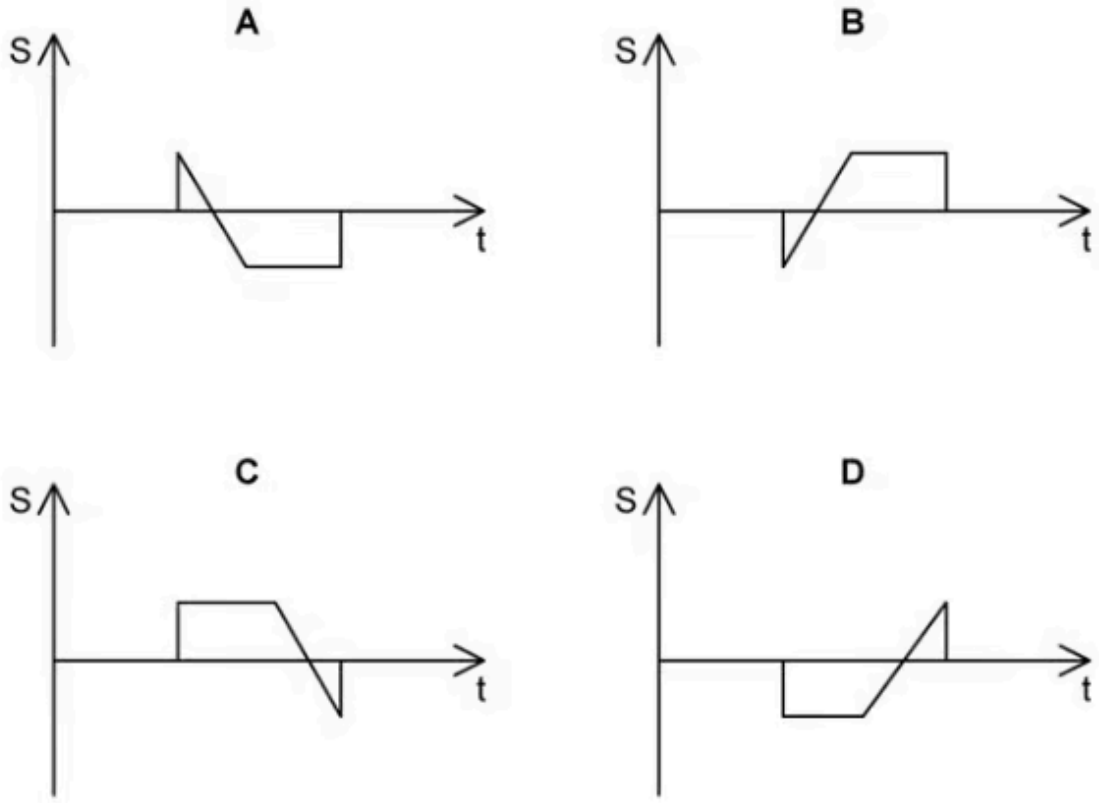
| | **Energy transferred along the standing wave** | **Amplitude of vibrations along the standing wave** |
|---|---|---|
| A. | None | Varies |
| B. | None | Is constant |
| C. | Some energy transferred | Varies |
| D. | Some energy transferred | Is constant |

**(1 mark)**

**20** The diagram shows a wave moving along a rope under tension in the direction shown.




Which of the following graphs, **A** to **D,** correctly shows the variation of displacement *s* with time *t* of the particle K in the rope?




**(1 mark)**

**21** A star emits light of frequency $f$. This light is observed on Earth to have a frequency $f'$ which is of a lower frequency than $f$.

Which of the following correctly describes the speed and direction of motion of the star?

| | Speed | Direction |
|---|---|---|
| **A.** | $\frac{(f-f')}{f}c$ | Towards Earth |
| **B.** | $\frac{(f-f')}{f'}c$ | Towards Earth |
| **C.** | $\frac{(f-f')}{f}c$ | Away from Earth |
| **D.** | $\frac{(f-f')}{f'}c$ | Away from Earth |

**(1 mark)**

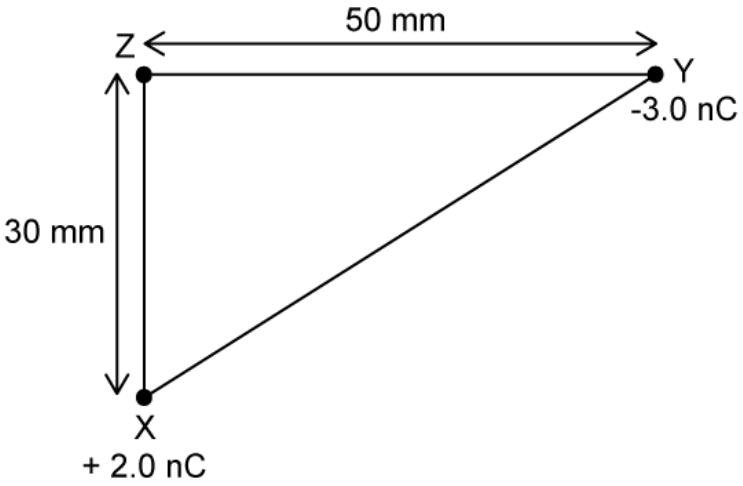
**22** The Hubble space telescope has a mirror of diameter 2 m and works with cameras that operate with wavelengths between 100 nm - 1000 nm. It can be pointed at a distant star with an accuracy of of about $4 \times 10^{-8}$ rad.

What is the theoretical limit of resolution using each of the wavelengths quoted?

| | **$\lambda$ = 100 nm** | **$\lambda$ = 1000 nm** |
|---|---|---|
| **A.** | $6.1 \times 10^{-6}$ rad | $6.1 \times 10^{-5}$ rad |
| **B.** | $1.0 \times 10^{-7}$ rad | $5.7 \times 10^{-7}$ rad |
| **C.** | $3.4 \times 10^{-5}$ rad | $4.5 \times 10^{-8}$ rad |
| **D.** | $2.1 \times 10^{-8}$ rad | $6.5 \times 10^{-7}$ rad |

**(1 mark)**

**23** Point charges of +2.0 nC and −3.0 nC are arranged at the corners X and Y of a triangle with sides of 50 mm and 30 mm as shown.




Which is the best estimate for the value of the ratio of the electric field at Z due to X and the electric field due to Y, $\frac{E_X}{E_Y}$?

**A.** $\frac{27}{20}$

**B.** $\frac{20}{27}$

**C.** $\frac{27}{50}$

**D.** $\frac{50}{27}$

**(1 mark)**

**24** A science student who lives in the UK, where the mains voltage is 240 V, buys a light bulb marked 60 W which she uses in her bedroom. The student takes the lightbulb with her on a trip to Canada where the mains voltage is 100 V and also uses it there.

Which line correctly identifies the approximate power dissipated in the bulb in the UK and Canada?

| | UK / W | Canada / W |
|---|---|---|
| **A.** | 30 | 10 |
| **B.** | 60 | 30 |
| **C.** | 60 | 10 |
| **D.** | 120 | 60 |

**A.**

**(1 mark)**

**25** Which of the following statements about discharging cells is incorrect?

**A.** The capacity of a cell is proportional to the amount of charge delivered to an external circuit over a cell's lifetime

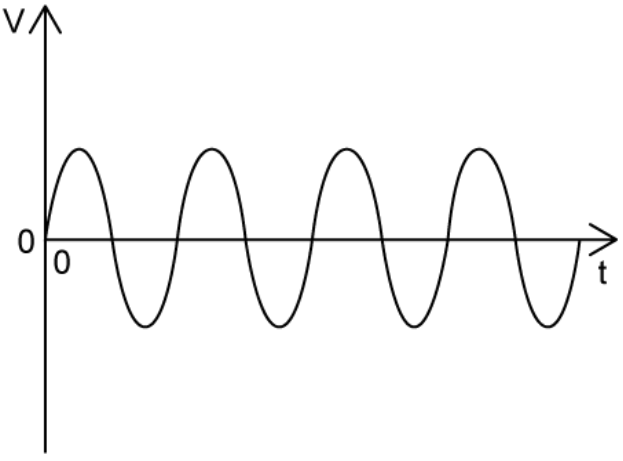
**B.** The lifetime of a cell depends on its capacity

**C.** The lifetime of a cell depends on the current it produces

**D.** The internal resistance of a cell gradually increases over its lifetime

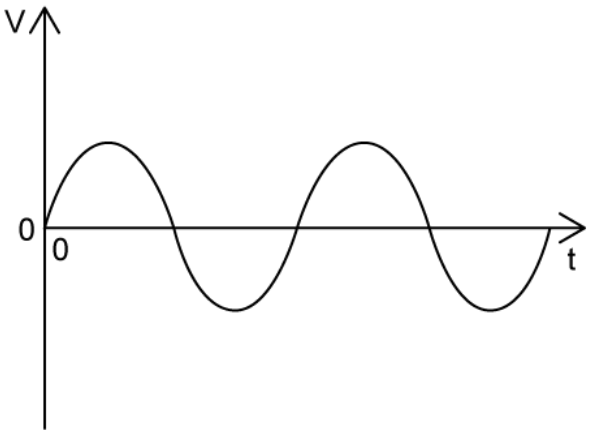
**(1 mark)**

**26** The graph shows the variation with time t of the output voltage V of an ac generator.

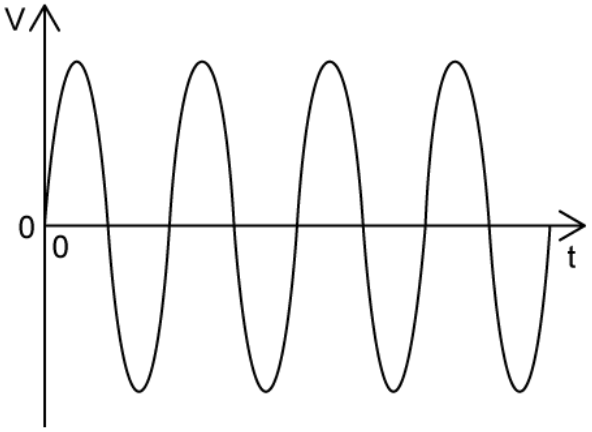



Which graph, with identical scales on the axes, shows the output when the speed of rotation is doubled?

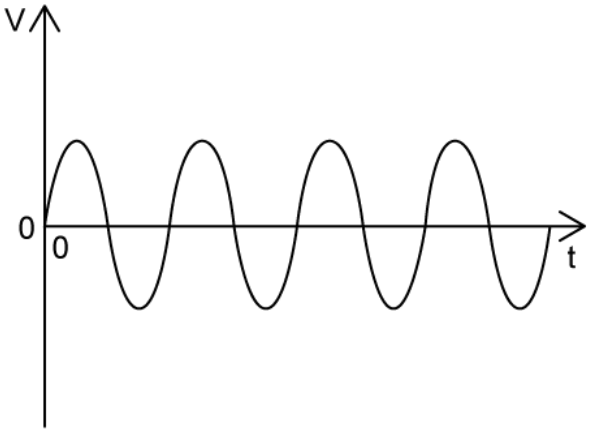
**A.**



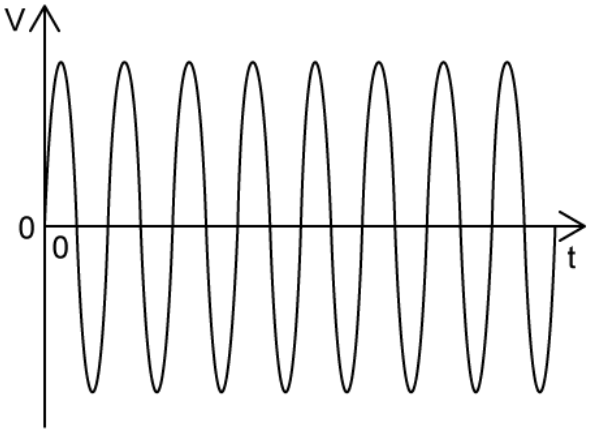

**B.**




**C.**

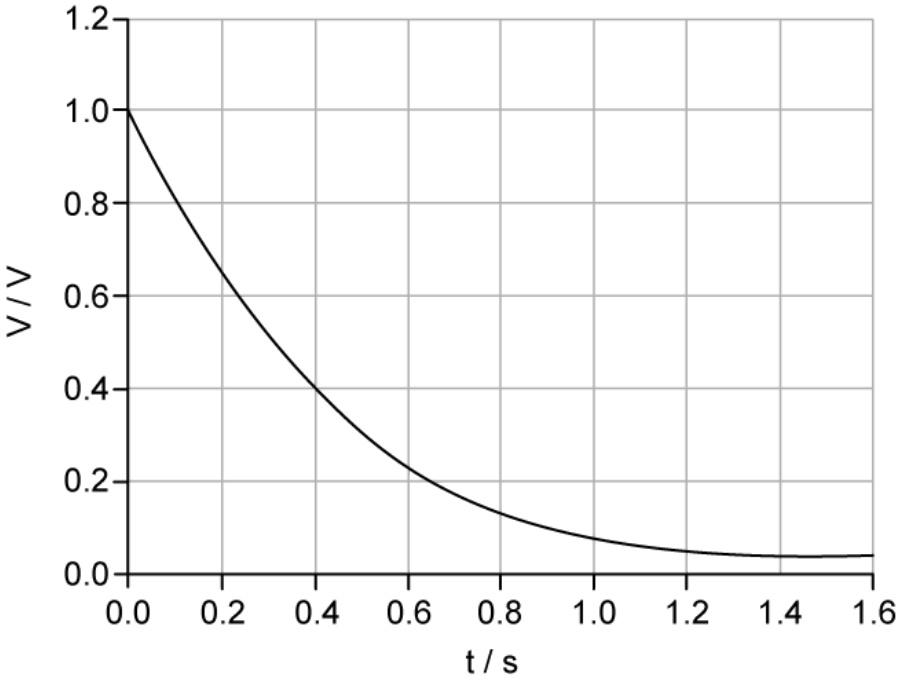


**D.**

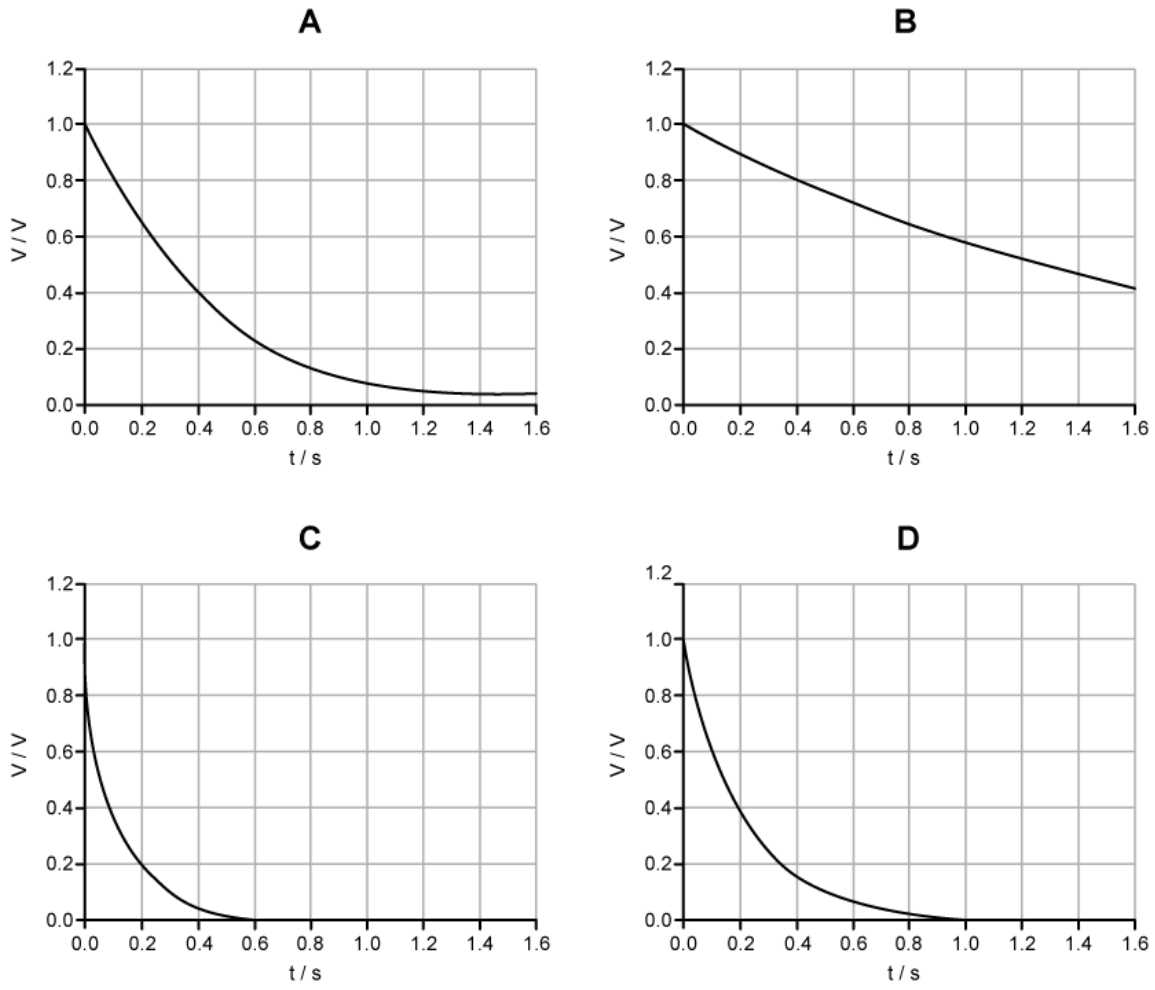



**(1 mark)**

**27** A capacitor of capacitance *C* discharges through a resistor of resistance *R*. The graph shows the variation with time *t* of the voltage *V* across the capacitor.

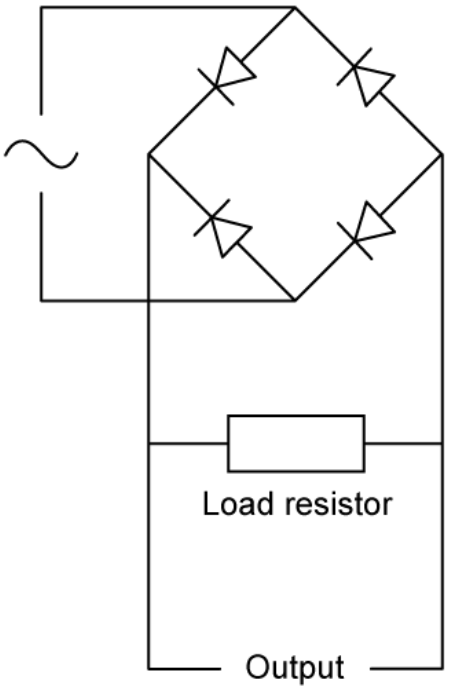



The capacitor is changed to one of value $\frac{C}{2}$ and the resistor is changed to one of value $\frac{R}{2}$. Which graph shows the variation with *t* of *V* when the new combination is discharged?



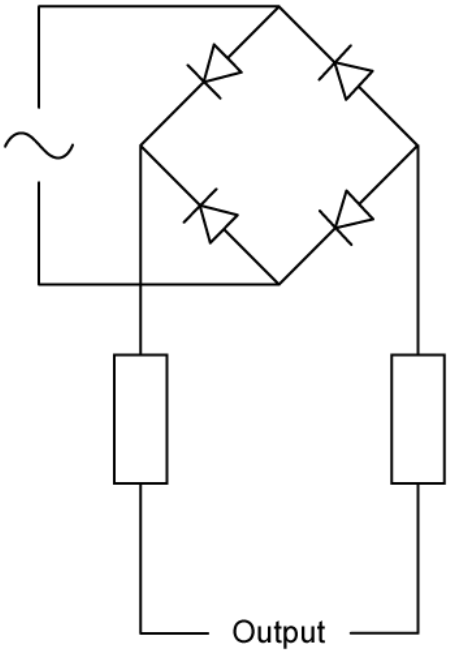

**(1 mark)**

**28** The diagram shows a diode bridge rectification circuit connected to a load resistor.

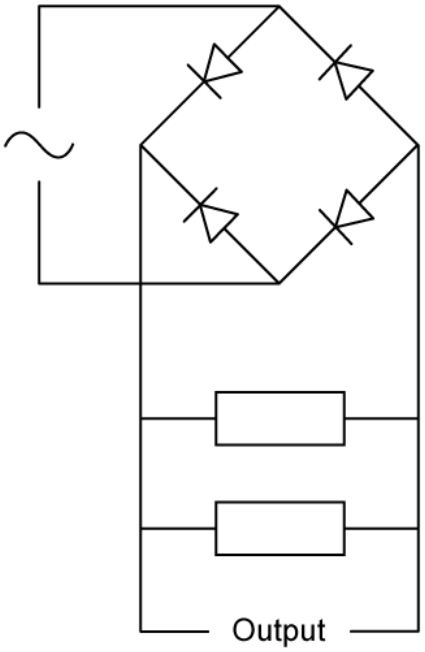



Which change to the circuit will produce an output signal showing the most smoothing?

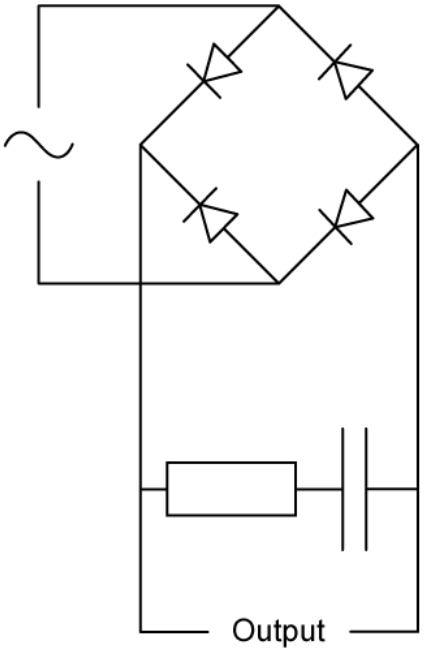
**A.**



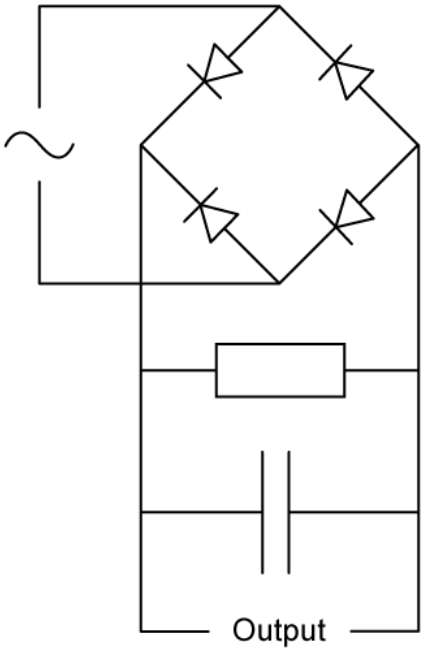
**B.**




**C.**

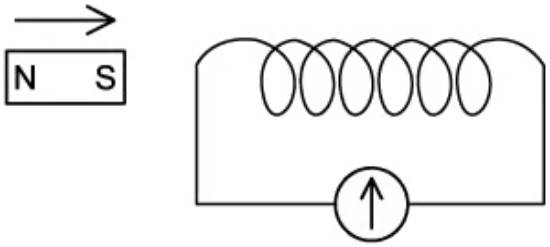


**D.**




**(1 mark)**

**29** The south pole of a bar magnet is pushed into one end of a coil of wire, which is connected to a sensitive galvanometer as shown:




A galvanometer measures the amount of current through a moving coil, shown by a deflecting needle. A maximum deflection of the galvanometer needle of 7 units to the right is observed.

Next, the north pole of the magnet is pushed into the other end of the coil at twice the speed.

What would be the maximum deflection of the galvanometer needle?

**A.** Less than 7 units to the right

**B.** Less than 7 units to the left

**C.** More than 7 units to the right

**D.** More than 7 units to the left

**(1 mark)**

**30** A probe is launched from the surface of the Earth, which has a radius *R*, at half the required escape velocity.

What is the maximum height from the surface the probe will reach, before returning to the ground (with a bang)?

**A.** $R$

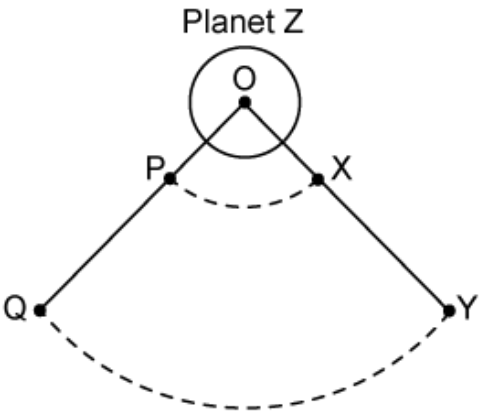
**B.** $\frac{R}{2}$

**C.** $\frac{R}{3}$

**D.** $\frac{R}{4}$

**(1 mark)**

**31** Planet Z, with centre O, is shown in the figure below.



The radial distances OP is equal to the OX, and OQ is equal to OY, such that PX and QY are loci of Planet Z.

Which of the following statements is incorrect?

**A.** The work done by the gravitational field on a test mass moving from P to Q is negative

**B.** The gravitational field does zero work on a test mass moving along the locus PX

**C.** $\frac{V_X}{V_Q} = \frac{OY}{OX}$

**D.** The work done by an external force to move a test mass from Y to X is positive

**(1 mark)**

**32** A body moves in a circle with increasing angular velocity. At times *t*, the angles *θ* swept out by the body added cumulatively from the same reference point and its angular velocities *ω* are as follows:

| t / s | *θ* / rad | *ω* / rad $s^{-1}$ |
|---|---|---|
| 5 | 2 | 0.4 |
| 15 | 16 | 2.4 |
| 25 | 42 | 4.4 |
| 35 | 80 | 6.4 |

The angular acceleration of the body:

**A.** is constant at 0.2 rad $s^{-2}$

**B.** gradually decreases and is 6.25 rad $s^{-2}$ when t = 15 s

**C.** is constant at 0.4 rad $s^{-2}$

**D.** increases at a constant rate and is 0.2 rad $s^{-2}$ when t = 15 s

**(1 mark)**

**33** Protactinium-231 ($^{231}_{91}Pa$) is a radioactive element, it decays by alpha radiation and then beta-minus decay as shown below:

$$^{231}_{91}Pa \rightarrow A + \alpha \rightarrow B + \beta^{-} + \overline{\upsilon}_{e}$$

What proton number and mass number will element **B** have?

| | Proton Number | Mass Number |
|---|---|---|
| **A.** | 89 | 229 |
| **B.** | 90 | 229 |
| **C.** | 89 | 227 |
| **D.** | 90 | 227 |

**(1 mark)**

**34** The decay of a neutral kaon $K^0$ is given by the equation

$$K^0 \rightarrow X + Y + \overline{\nu}_{e}$$

What must particles X and Y be?

**A.** $\pi^+$ and $e^-$

**B.** $\pi-$ and $e^+$

**C.** $\mu^+$ and $e^-$

**D.** $\pi^+$ and $\mu^-$

**(1 mark)**

**35** None of the following decay equations for baryons are permitted.

Equation 1: $n \rightarrow p + e^{-} + \nu_e$

Equation 2: $\Delta^{+} \rightarrow \pi^{+} + \pi^{0}$

Equation 3: $p \rightarrow n + e^{-} + \nu_e$

Equation 4: $\equiv^{0} \rightarrow p + \bar{\nu} + \pi^{0}$

Which property is not conserved in each equation?

| | **Equation 1** | **Equation 2** | **Equation 3** | **Equation 4** |
|---|---|---|---|---|
| **A** | charge | baryon number | charge and lepton number | baryon number |
| **B** | lepton number | baryon number | charge and lepton number | charge and lepton number |
| **C** | baryon number | lepton number | baryon number | lepton number and baryon number |
| **D** | lepton number | charge | charge | charge |

**(1 mark)**

**36** Following the development of the atomic bomb, scientists discovered that they could create elements heavier than uranium by bombarding nuclei with neutrons. These reactions, where smaller nuclei are combined to form a heavier nucleus are called fusion reactions.

Fusion reactions are balanced in exactly the same way as radioactive decay equations. Two incomplete examples are given below:

Reaction 1. $^{238}_{92}U + {}^{1}_{0}n \rightarrow \quad U$

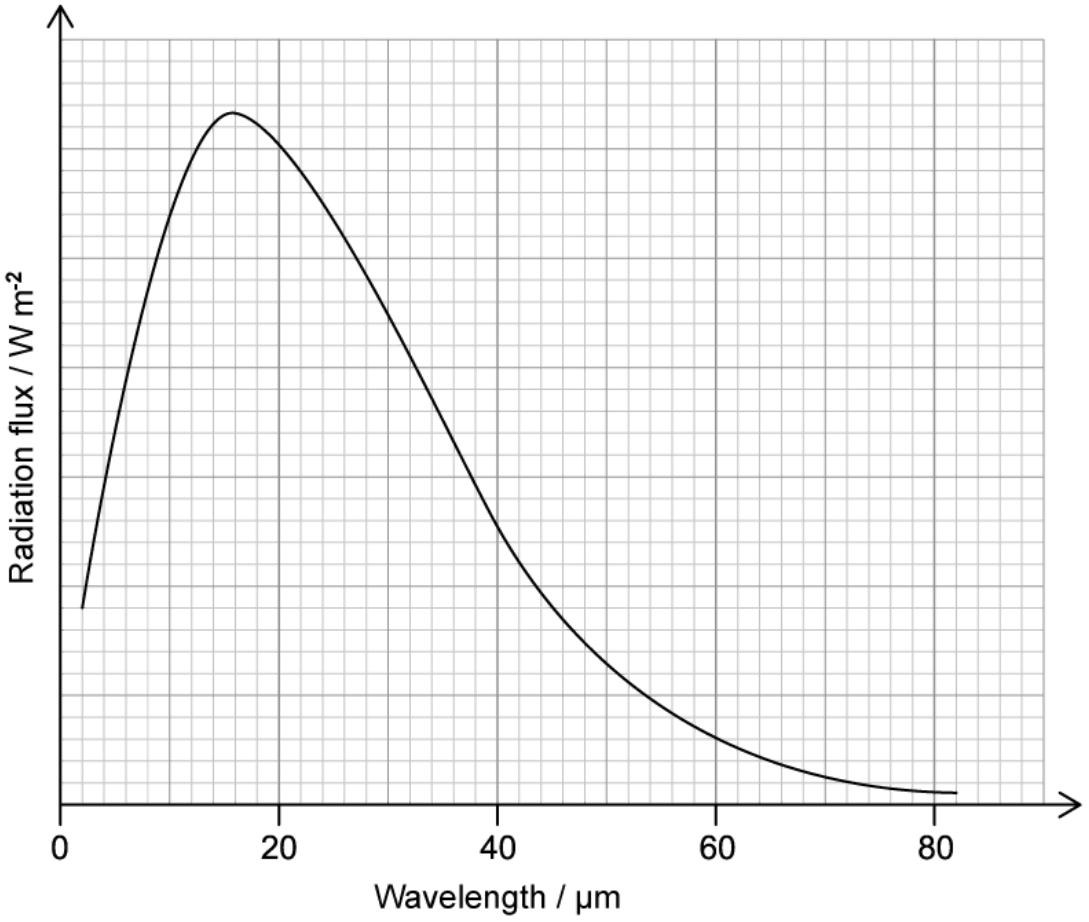
Reaction 2. $^{239}_{94}Pu + 2\,{}^{1}_{0}n \rightarrow \quad Am + {}^{0}_{-1}e$

What are the missing products of these fusion reactions?

| | Reaction 1 | Reaction 2 |
|---|---|---|
| **A.** | $^{239}_{92}U$ | $^{240}_{95}Am$ |
| **B.** | $^{239}_{92}U$ | $^{241}_{95}Am$ |
| **C.** | $^{237}_{92}U$ | $^{237}_{95}Am$ |
| **D.** | $^{237}_{92}U$ | $^{241}_{95}Am$ |

**(1 mark)**

**37** The radiation emitted from an asteroid is monitored and the following spectrum is obtained.



Which of the following is a sensible estimate for the temperature of the asteroid.

**A.** 1500 K

**B.** $\frac{375}{2}$ K

**C.** $4.8 \times 10^{-8}$ K

**D.** $\frac{16}{3}$ K

**(1 mark)**

**38** A subatomic particle of mass *m* has an uncertainty in its position *r*, denoted by Δ*r*. What is the uncertainty in its velocity, Δ*v*?

**A.** $\frac{hm}{4\pi\Delta r}$

**B.** $\frac{h}{4\pi\Delta r}$

**C.** $\frac{h}{4\pi m\Delta r}$

**D.** $\frac{h}{4\pi}$

**(1 mark)**

**39** Which expression evaluates the de Broglie wavelength of an electron of mass *m* and charge *e* in the *n* = 2 state of hydrogen?

**A.** $\frac{h}{\sqrt{2me}}$

**B.** $\frac{h}{\sqrt{3.4me}}$

**C.** $\frac{h}{\sqrt{6.8me}}$

**D.** $\frac{h}{\sqrt{13.6me}}$

**(1 mark)**

**40** Two radioactive elements X and Y have half–lives $T_X$ and $T_Y$ respectively. Each sample contains an initial number of atoms $N_X$ and $N_Y$ respectively. Sample X initially contains three times as many atoms as sample Y.

The number of atoms remaining in a sample after a time $t$ is given by

$$N(t) = N_0\left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$$

Which of the expressions for $\frac{number\ of\ decayed\ atoms\ of\ X}{number\ of\ decayed\ atoms\ of\ Y}$ is correct?

**A.** $\frac{\frac{3}{2}\left(N_Y - N_Y\left(\frac{1}{2}\right)^{\frac{t}{T_X}}\right)}{\frac{1}{2}N_Y - N_Y\left(\frac{1}{2}\right)^{\frac{t}{T_Y}}}$

**B.** $\frac{N_X\left(\frac{1}{2}\right)^{\frac{t}{T_X}} - \frac{1}{2}N_X}{N_Y\left(\frac{1}{2}\right)^{\frac{t}{T_Y}} - \frac{1}{2}N_Y}$

**C.** $\frac{N_X\left(\frac{1}{2}\right)^{\frac{t}{T_X}}}{N_Y\left(\frac{1}{2}\right)^{\frac{t}{T_Y}}}$

**D.** $\frac{3N_Y\left(\frac{1}{2}\right)^{\frac{t}{T_X}}}{N_Y\left(\frac{1}{2}\right)^{\frac{t}{T_Y}}}$

**(1 mark)**