Name: ______________________________ (   )   Class: 24 / ______

ANDERSON SERANGOON JUNIOR COLLEGE

2023 JC1 Promotional Exam

PHYSICS Higher 2 — 9749/01

Paper 1 Multiple Choice — **Tuesday 26 September 2023**

40 minutes

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name and class on the Multiple Choice Answer Sheet.
Shade and write your NRIC/FIN.

There are **twenty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Multiple Choice Answer Sheet.

Read the instructions on the Multiple Choice Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this question paper.
The use of an approved scientific calculator is expected, where appropriate.

Data

speed of light in free space	$c = 3.00 \times 10^{8}$ m s^{-1}
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ F m^{-1}
	$(1/(36\pi)) \times 10^{-9}$ F m^{-1}
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ J s
unified atomic mass constant	$u = 1.66 \times 10^{-27}$ kg
rest mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
molar gas constant	$R = 8.31$ J K^{-1} mol^{-1}
the Avogadro constant	$N_A = 6.02 \times 10^{23}$ mol^{-1}
the Boltzmann constant	$k = 1.38 \times 10^{-23}$ J K^{-1}
gravitational constant	$G = 6.67 \times 10^{-11}$ N m^{2} kg^{-2}
acceleration of free fall	$g = 9.81$ m s^{-2}

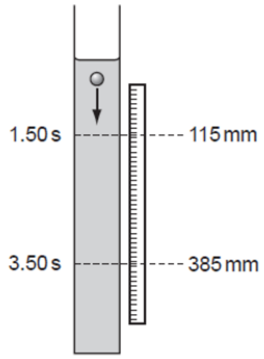
Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas	$W = p\Delta V$
hydrostatic pressure	$p = \rho gh$
gravitational potential	$\phi = -\dfrac{Gm}{r}$
temperature	$T/\text{K} = T/°\text{C} + 273.15$
pressure of an ideal gas	$p = \dfrac{1}{3}\dfrac{Nm}{V}\langle c^2 \rangle$
mean translational kinetic energy of an ideal gas molecule	$E = \frac{3}{2}kT$
displacement of particle in s.h.m.	$x = x_0 \sin \omega t$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$
	$= \pm\omega\sqrt{x_o{}^2 - x^2}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential	$V = \dfrac{Q}{4\pi\varepsilon_o r}$
alternating current/voltage	$x = x_0 \sin \omega t$
magnetic flux density due to a long straight wire	$B = \dfrac{\mu_o I}{2\pi d}$
magnetic flux density due to a flat circular coil	$B = \dfrac{\mu_o NI}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_o nI$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \dfrac{\ln 2}{t_{\frac{1}{2}}}$

1 What is a reasonable estimate of the acceleration of an MRT train leaving a station in Singapore?

A 0.1 m s^{-2} **B** 1 m s^{-2} **C** 10 m s^{-2} **D** 100 m s^{-2}

2 The diagram shows an experiment to measure the speed of a small ball falling at constant speed through a clear liquid in a glass tube.



There are two marks on the tube. The top mark is positioned at 115 ± 1 mm on the adjacent rule and the lower mark at 385 ± 1 mm. The ball passes the top mark at 1.50 ± 0.02 s and passes the lower mark at 3.50 ± 0.02 s.

The constant speed of the ball is calculated by

$$\frac{385-115}{3.50-1.50}=\frac{270}{2.00}=135\text{ mm s}^{-1}$$

Which expression calculates the fractional uncertainty in the value of this speed?

A $\frac{2}{270}+\frac{0.04}{2.00}$

B $\frac{2}{270}-\frac{0.04}{2.00}$

C $\frac{1}{270}\times\frac{0.02}{2.00}$

D $\frac{1}{270}\div\frac{0.02}{2.00}$

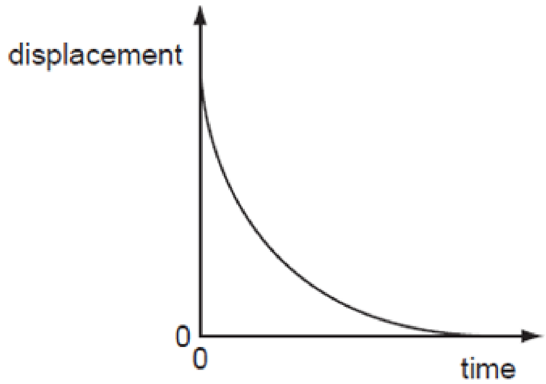
3 A sprinter takes a time of 11.0 s to run a 100 m race. She first accelerates uniformly from rest, reaching a speed of 10 m s^{-1}. She then runs at a constant speed of 10 m s^{-1} until the finish line.

What is the uniform acceleration of the sprinter for the first part of the race?

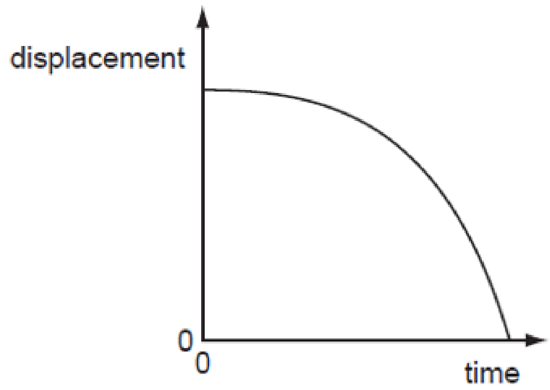
A 0.5 m s^{-2} **B** 0.91 m s^{-2} **C** 1.7 m s^{-2} **D** 5.0 m s^{-2}

4 Which displacement-time graph best represents the motion of a falling sphere, the initial acceleration of which eventually reduces until it begins to travel at constant terminal velocity?

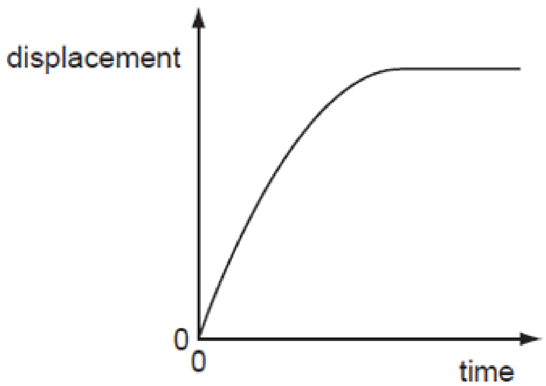
A



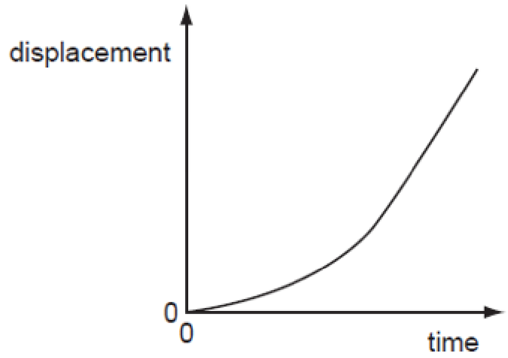
B



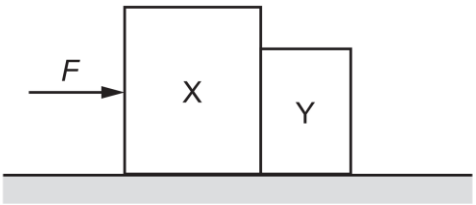
C



D



5 A single horizontal force F is applied to a block X which is in contact with a separate block Y, as shown.



The blocks remain in contact as they accelerate along a horizontal frictionless surface. Air resistance is negligible. X has a greater mass than Y.

Which statement is correct?

A The acceleration of X is equal to force F divided by the mass of X.

B The force that X exerts on Y is equal to F.

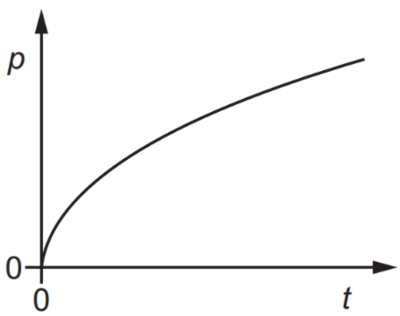
C The force that X exerts on Y is less than F.

D The force that X exerts on Y is less than the force that Y exerts on X.

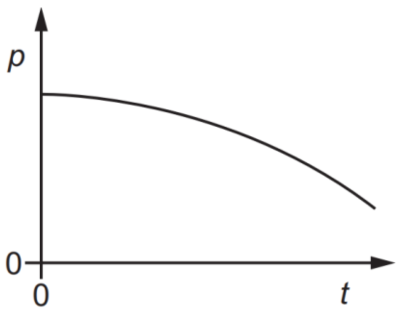
6 The resultant force acting on an object is slowly increased.

Which graph shows the variation with time t of the momentum p of the object?

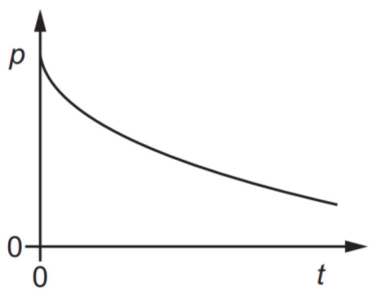
A



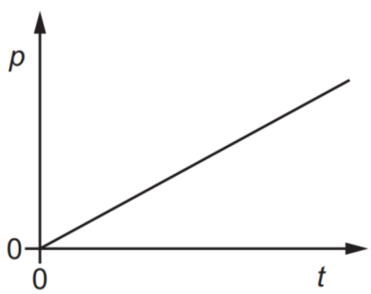
B



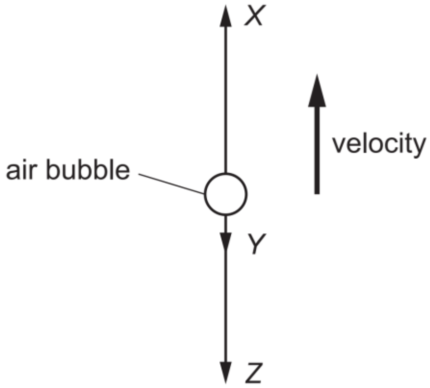
C



D



7 An air bubble in a tank of water is rising with constant velocity. The forces acting on the bubble are X, Y, and Z as shown.



Which of the following describes the three forces?

A Z is the viscous drag on the bubble, Y is the weight of the bubble, X is the upthrust on the bubble and $X = Y + Z$.

B Z is the viscous drag on the bubble, Y is the weight of the bubble, X is the upthrust on the bubble and $X > Y + Z$.

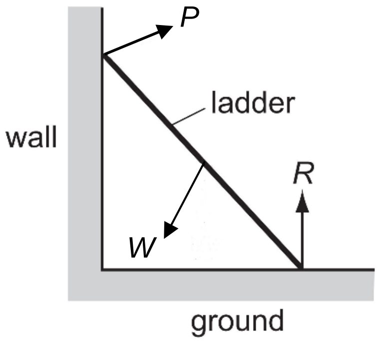
C Z is the weight of the bubble, Y is viscous drag on the bubble, X is the upthrust on the bubble and $X = Y + Z$.

D Z is the weight of the bubble, Y is viscous drag on the bubble, X is the upthrust on the bubble and $X > Y + Z$.

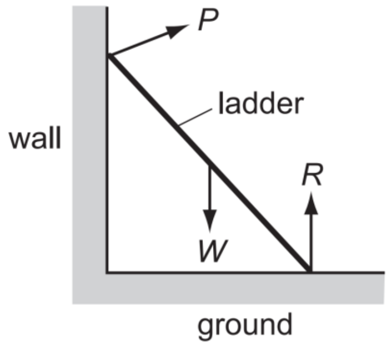
8 A ladder is positioned on icy (frictionless) ground and is leant against a rough wall. At the instant of release it begins to slide.

Which diagram correctly shows the directions of the forces *P*, *W* and *R* acting on the ladder as it begins to slide?

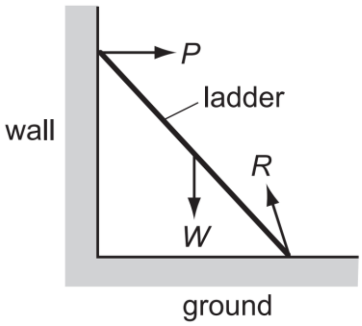
A



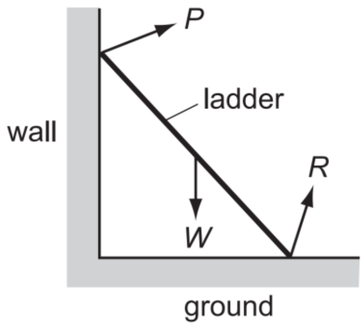
B



C



D

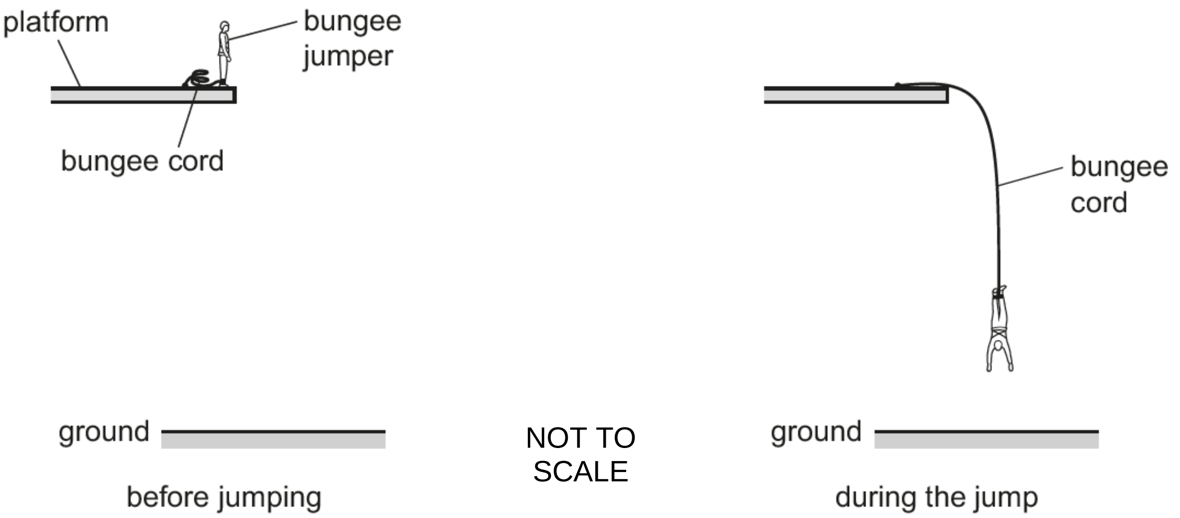


9 The total energy input E_{in} in a process is partly transferred to useful energy output *U* and partly transferred to energy that is wasted *W*.

What is the efficiency of the process?

A $\dfrac{U}{E_{in}} \times 100\%$ **B** $\dfrac{W}{E_{in}} \times 100\%$ **C** $\dfrac{U}{W} \times 100\%$ **D** $\dfrac{U+W}{E_{in}} \times 100\%$

10 A bungee jumper jumps from a platform and is decelerated by an elastic bungee cord, as shown.



When the jumper makes the jump, his initial gravitational potential energy is converted into his kinetic energy and into elastic potential energy in the cord.

At which part of the jump are all three types of energy non-zero?

A On the platform before the jump.

B On the way down before the cord has started to extend.

C On the way down when the net force acting on the jumper is zero.

D At the point when the cord is stretched to a maximum.

11 The diagram shows an analogue watch.

What is the average angular velocity of the hour hand?

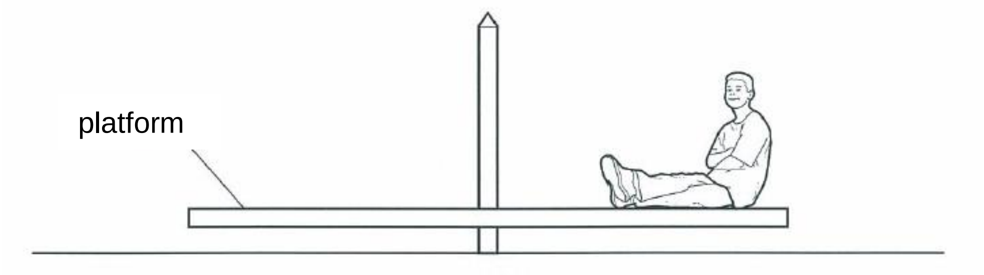
A 2.31×10^{-5} rad s^{-1}

B 7.27×10^{-5} rad s^{-1}

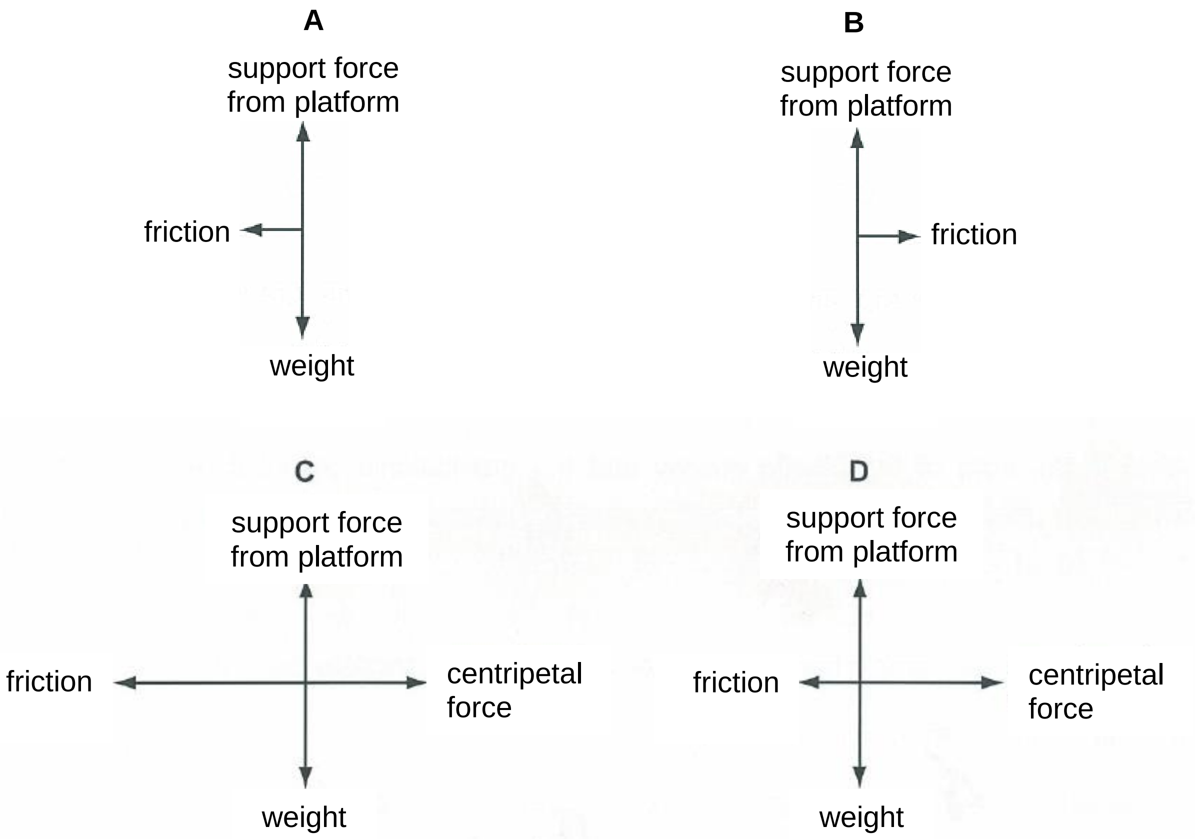
C 1.45×10^{-4} rad s^{-1}

D 1.75×10^{-3} rad s^{-1}

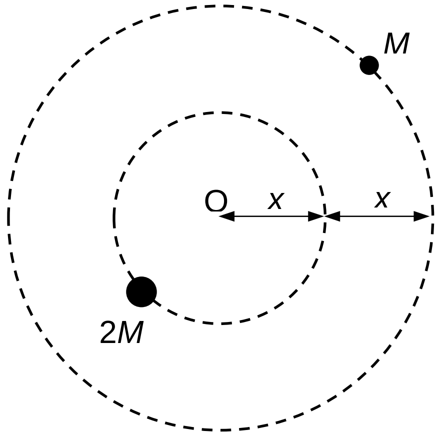
12 The diagram shows a child sitting on a playground turntable, which is turning with constant angular velocity.



Which diagram shows the forces acting on the child when in the position shown?



13 Two stars of masses M and $2M$, a distance $3x$ apart, rotate in circular orbits about their common centre of mass O.



The gravitational force acting on the stars can be written as $\dfrac{kGM^2}{x^2}$.

What is the value of k?

A 0.22 **B** 0.50 **C** 0.67 **D** 2.0

14 A satellite is moved from a circular orbit of radius R_1 around the Earth to a new circular orbit of radius R_2 where $R_2 > R_1$.

What happens to its kinetic energy and gravitational potential energy?

	kinetic energy	gravitational potential energy
A	increases	increases
B	increases	decreases
C	decreases	increases
D	decreases	decreases

15 Which statement about a geostationary satellite is true?

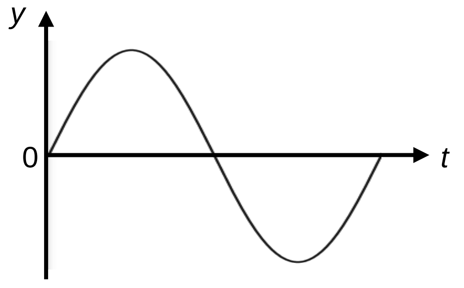
A It is always travelling from east to west.

B It can remain vertically above any chosen fixed point on the Earth.

C It has the same angular velocity as the Earth's rotation on its axis.

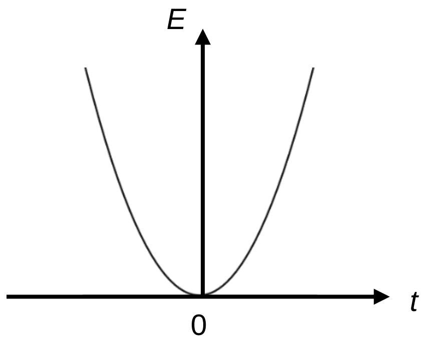
D Its linear speed is equal to the speed of a point on the Earth's equator.

16 The oscillations of a mass suspended on a spring are simple harmonic.
The variation with time t of the displacement y of the mass is shown.

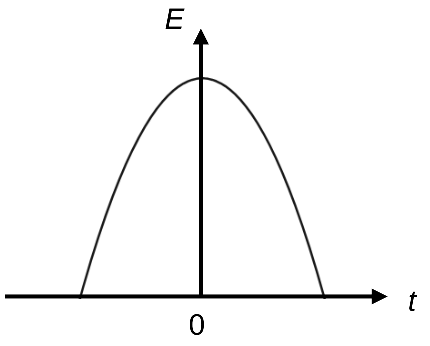


Which graph shows the variation with time t of the kinetic energy E of the mass?

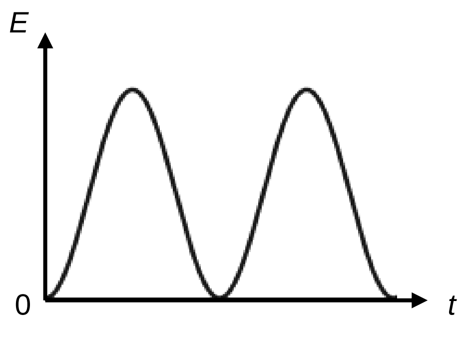
A



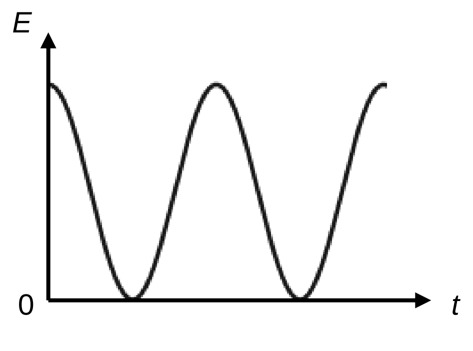
B



C

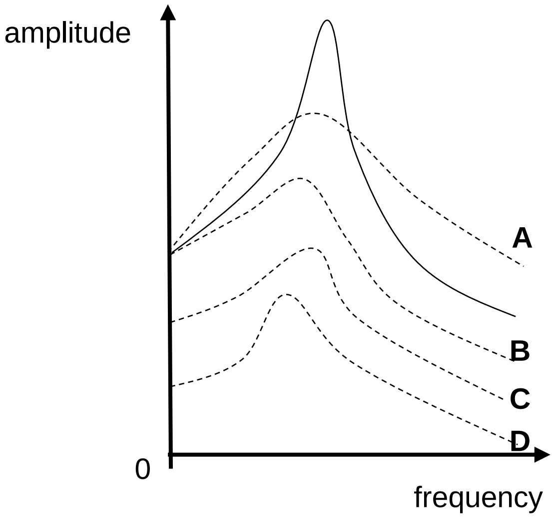


D

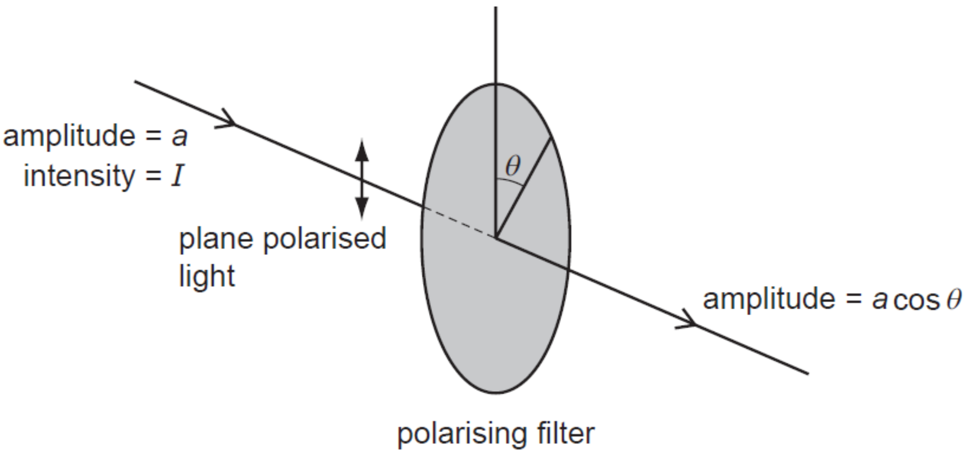


17 The solid line X on the graph shows how the amplitude of an oscillating system varies with the frequency at which it is driven. The driving oscillator has a constant amplitude at all frequencies.

Which dashed line shows the response of the system under conditions where there is more damping?



18 When plane-polarised light of amplitude *a* is passed through a polarising filter as shown, the amplitude of the light emerging is $a \cos \theta$.



The intensity of the initial beam is I.

What is the intensity of the emerging light when θ is 60.0°?

A $0.250\,I$ **B** $0.500\,I$ **C** $0.750\,I$ **D** $0.866\,I$

19 Diagram 1 shows a ripple tank experiment in which plane waves are diffracted through a narrow slit in a metal sheet.

Diagram 2 shows the same tank with a slit of greater width.

In each case, the pattern of the waves incident on the slit and the emergent pattern are shown.

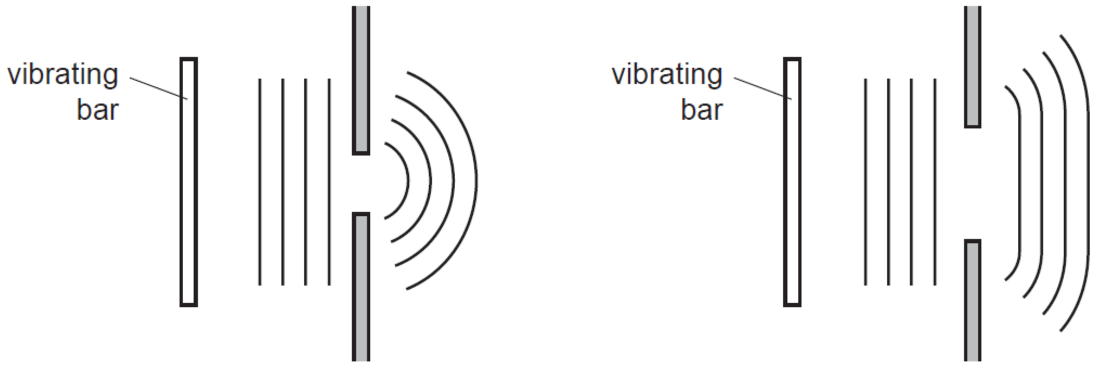


diagram 1 diagram 2

Which action would cause the waves in diagram 1 to be diffracted less and so produce an emergent pattern closer to that shown in diagram 2?

A increasing the speed of the waves by making the water in the tank deeper

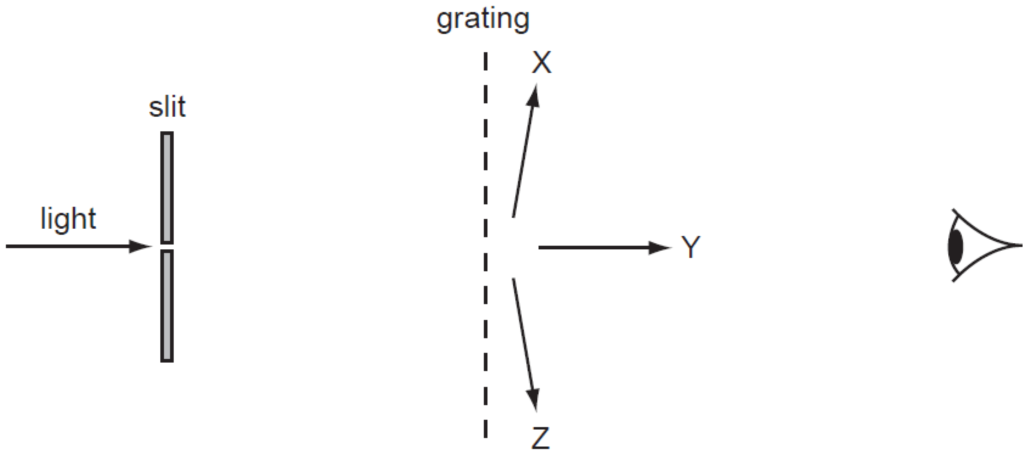
B increasing the frequency of vibration of the bar

C reducing the amplitude of vibration of the bar

D reducing the length of the vibrating bar

20 A diffraction grating with 500 lines per mm is used to observe diffraction of monochromatic light of wavelength 600 nm.

The light is passed through a narrow slit and the grating is placed so that its lines are parallel to the slit. Light passes through the slit and then the grating.



An observer views the slit through the grating at different angles, moving his head from X parallel to the grating, through Y, opposite the slit, to Z parallel to the grating on the opposite side.

How many images of the slit does he see?

A 3 **B** 4 **C** 6 **D** 7

BLANK PAGE