EUNOIA JUNIOR COLLEGE
JC1 PROMOTIONAL EXAMINATIONS 2021
General Certificate of Education Advanced Level
Higher 2

PHYSICS

Paper 1 Multiple Choice

9749/01

September/October 2021

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use paper clips, glue or correction fluid.
Write your name, civics group and registration number on the Answer Sheet in the spaces provided.

There are **thirty** 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 Answer Sheet.

Read the instructions on the 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 booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **15** printed pages and **1** blank page.

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}
	$\left(1/\left(36\pi\right)\right) \times 10^{-9}$ 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, $\phi = -\frac{Gm}{r}$

temperature, $T\ /\ \mathrm{K} = T\ /\ ^\circ\mathrm{C} + 273.15$

pressure of an ideal gas, $p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$

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. $v = v_0 \cos \omega t$

$= \pm\ \omega \sqrt{\left(x_0^2 - x^2\right)}$

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, $V = \frac{Q}{4\pi\varepsilon_0 r}$

alternating current/voltage, $x = x_0 \sin \omega t$

magnetic flux density due to a long straight wire $B = \frac{\mu_0 I}{2\pi d}$

magnetic flux density due to a flat circular coil $B = \frac{\mu_0 NI}{2r}$

magnetic flux density due to a long solenoid $B = \mu_0 nI$

radioactive decay, $x = x_0 \exp(-\lambda t)$

decay constant $\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

1 A particular classroom is of dimensions 18 m by 9.5 m by 4.0 m.

How many standard Rubik's Cubes can the classroom approximately contain?

A 10^3
B 10^6
C 10^9
D 10^{12}

2 The speed *v* of surfaces waves of wavelength λ on a liquid of density ρ is given by

$$v = \sqrt{\frac{a\lambda}{2\pi} + \frac{2\pi b}{\rho\lambda}}$$

where *a* is a constant and *b* is a quantity that characterises the liquid.

Which of the following correctly indicates the SI base units for *a* and *b*?

	units of *a*	units of *b*
A	$m^{0.5}\ s^{-1}$	$kg^{0.5}\ m^2\ s^{-1}$
B	$m\ s^{-2}$	$kg\ s^{-2}$
C	$m^2\ s^{-2}$	$kg^{-0.5}\ m^2\ s^{-1}$
D	$m\ s^{-2}$	$kg\ m^{-2}$

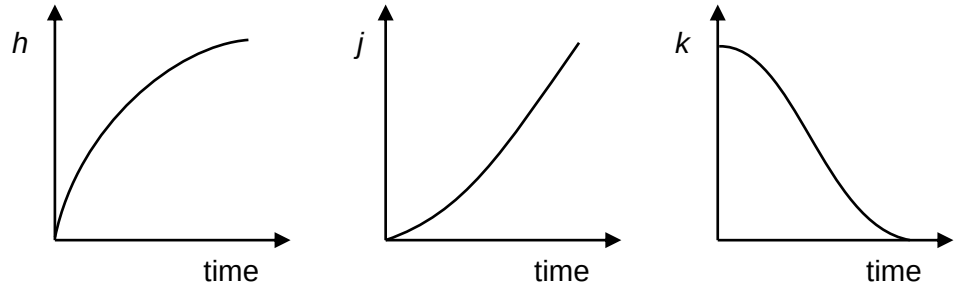
3 The measurements and the associated uncertainties of a spherical object are given below

diameter: 1.85 ± 0.01 cm
mass: 12.6 ± 0.1 g

What is the uncertainty of density as determined from the above measurements?

A 3.80 ± 0.02 g cm^{-3}
B 3.80 ± 0.05 g cm^{-3}
C 3.80 ± 0.06 g cm^{-3}
D 3.8 ± 0.1 g cm^{-3}

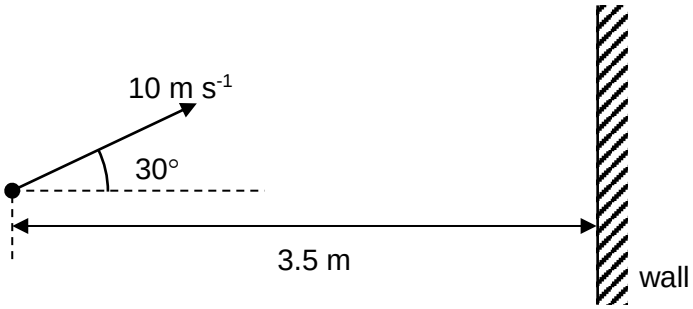
4 A rock is released from rest at a great height in air and falls due to gravity. Each of the three graphs shown below represents the variation with time of one of the three variables *h*, *j* and *k*.



Which of the following correctly identifies the three variables *h*, *j* and *k*?

	h	*j*	*k*
A	displacement	velocity	acceleration
B	acceleration	displacement	velocity
C	velocity	displacement	acceleration
D	velocity	acceleration	displacement

5 A ball is threw with an initial speed of 10 m s^{-1} at an elevation angle of 30° from the horizontal towards a tall vertical wall that is 3.5 m away.

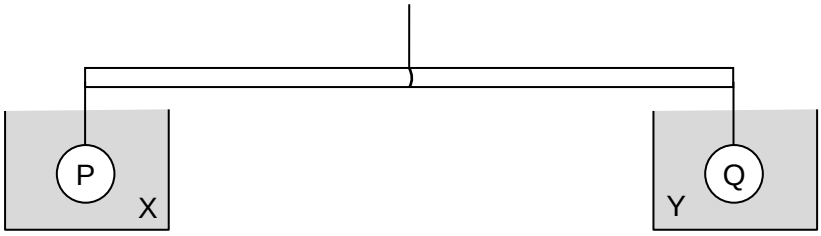


(not to scale)

At what distance above its initial position does the ball hit the wall?

A 0.40 m
B 0.50 m
C 1.2 m
D 5.1 m

6 Two objects P and Q have the same volume. They are both hung suspended from either ends of a light uniform rod and submerged in liquids X and Y respectively. The density of X is less than that of Y. The rod is horizontal when suspended from a string attached at the centre of the rod.

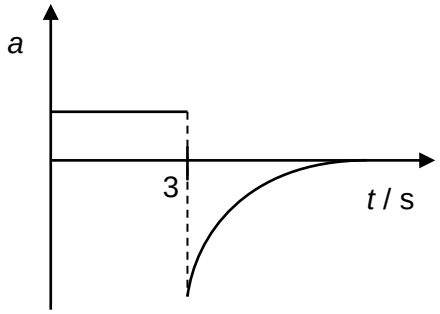


Which object has the smaller mass?

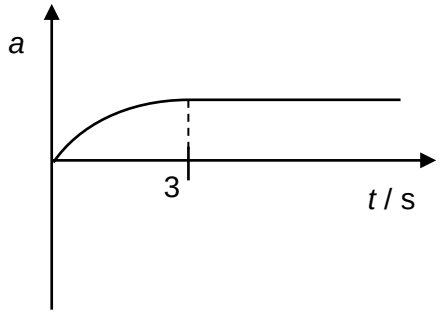
A P
B Q
C P and Q have the same mass
D insufficient information to tell

7 A parachutist leaves an aircraft and falls without significant drag for 3.0 s before opening the parachute. Which of the following best shows the variation of vertical acceleration *a* with time *t*?

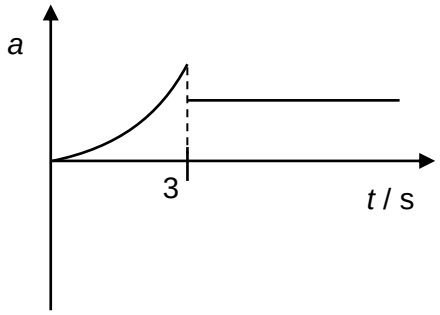
A



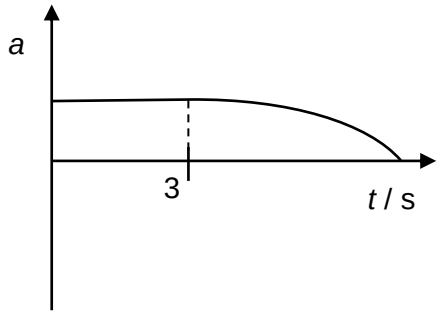
B



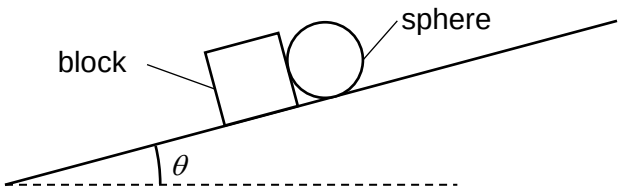
C



D



8 A block and a sphere of equal mass m are placed on an inclined plane. The maximum frictional force between the block and the plane has the same magnitude as the weight of the block. There is no frictional force between the sphere and the plane.



What is the maximum angle θ at which the plane can be inclined before the block starts to slip?

A 30°
B 45°
C 60°
D 90°

9 Particle X has kinetic energy E and momentum p. It undergoes a perfectly inelastic collision, head-on with particle Y which has the same mass and that is initially at rest.

Which of the following correctly represents the kinetic energies and momenta after the collision?

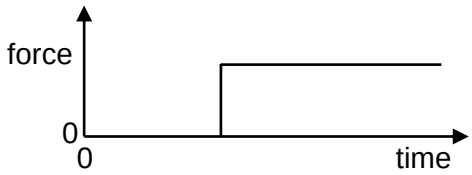
	kinetic energy of X	total kinetic energy of system	momentum of X	total momentum of system
A	0	0	0	0
B	0	E	0	p
C	$\frac{E}{4}$	$\frac{E}{2}$	$\frac{p}{4}$	$\frac{p}{2}$
D	$\frac{E}{4}$	$\frac{E}{2}$	$\frac{p}{2}$	p

10 The rotor blades of a helicopter pushes air vertically downwards at a speed of 15 m s^{-1}, with a mass flow rate of 2500 kg s^{-1}. The helicopter rises with constant acceleration of 12.5 m s^{-2}.

What is the mass of the helicopter?

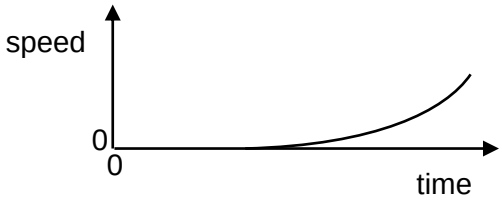
A 1680 kg
B 2500 kg
C 3000 kg
D 3750 kg

11 A car driver keeps his steering wheel centred and depresses his accelerator pedal fully when the traffic lights turn green. The resultant horizontal force acting on the car varies with time as shown.

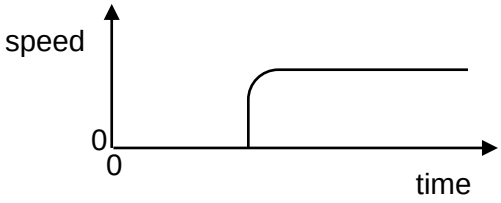


Which graph shows the variation with time of the speed of the car?

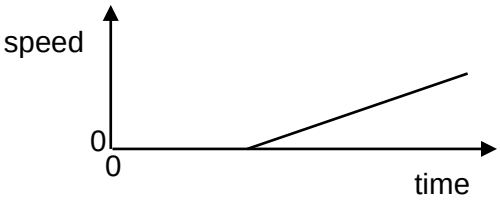
A



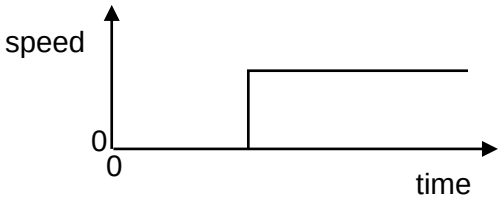
B



C



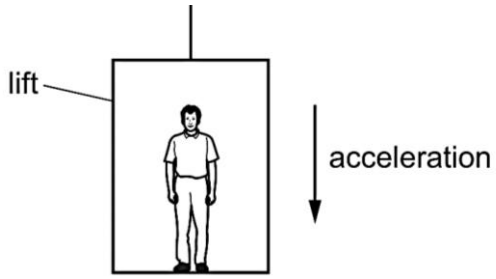
D



12 A cannon of mass 1000 kg initially at rest, fires a cannon ball of mass 10 kg. The cannon recoils with a horizontal speed of 5.0 m s^{-1}. What is the horizontal speed of the cannon ball?

A 200 m s^{-1}
B 500 m s^{-1}
C 2000 m s^{-1}
D 5000 m s^{-1}

13 A man stands in a lift that is accelerating vertically downwards as shown.



Which statement describes the force exerted by the man on the floor?

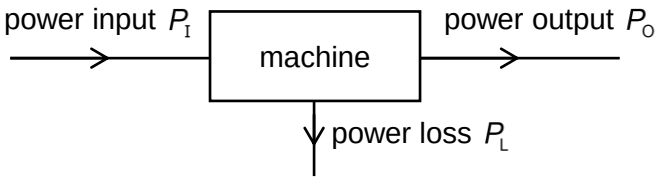
A It is equal to the weight of the man.
B It is greater than the force exerted by the floor on the man.
C It is less than the force exerted by the floor on the man.
D It is less than the weight of the man.

14 The first column in the table gives four examples of work being done. The second column gives more detail of the action.

Which row is correct?

	example	detail
A	a girl dives from a diving board into a swimming pool	work is done by the girl against gravity as she falls
B	a man pushes a car along a level road without skidding	work is done by the tyres against friction
C	an electron is accelerated towards a positively-charged plate	work is done by the electron against the electric field of the plate
D	a piston is pushed outwards as a gas expands	work is done on the atmosphere by the gas

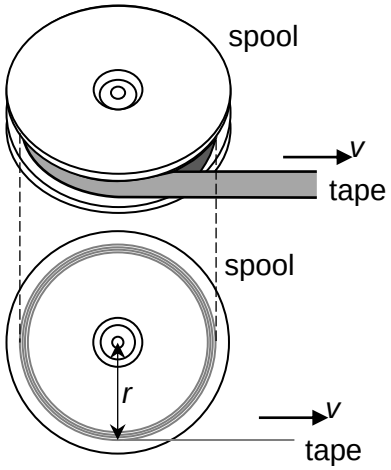
15 Power is transferred through a machine as shown.



What is the efficiency of the machine?

A $P_I / (P_O + P_L)$
B P_O / P_I
C P_L / P_I
D P_L / P_O

16 In a tape cassette, the tape leaves one spool at a constant speed v and at a variable distance r from the centre of the spool.



Which of the following correctly describes the angular velocity of the spool?

A The angular velocity is directly proportional to $\frac{1}{r^2}$.
B The angular velocity is directly proportional to $\frac{1}{r}$.
C The angular velocity is directly proportional to r.
D The angular velocity does not depend on r.

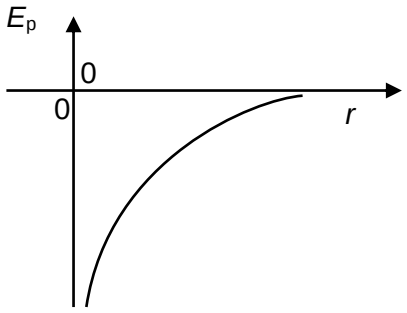
17 A car of mass 1000 kg turns with a circular radius of 100 m on a slope banked at 30°. The car has a constant speed of 90 km h^{-1}. What is the sidewards frictional force acting on the tyres?

A 508 N, downwards along the slope
B 508 N, upwards along the slope
C 6250 N, downwards along the slope
D 6250 N, upwards along the slope

18 A planet of mass M moves in a circular orbit of radius R round a star of mass S with period T. Which one of the following correctly shows how T depends on M, R, S?

A $T \propto M^2$
B $T \propto \sqrt{S}$
C $T \propto \sqrt{R}$
D $T \propto R^{1.5}$

19 The gravitational potential energy E_p of an object varies with its distance r from the centre of a planet as shown.



What does the gradient at any point on the curve represent?

A gravitational field strength of the object
B gravitational field strength of the planet
C gravitational force on the object
D gravitational force on the planet

20 P and Q are two points at a distance r and $2r$ from the centre of Earth respectively. The gravitational potential at P is -400 kJ kg^{-1}.

What is the work done on a body of mass 200 kg when the body is brought from Q to P?

A +40 MJ
B +80 MJ
C –40 MJ
D –80 MJ

21 A geostationary satellite of mass 500 kg is in a stable orbit around Earth. Given that the mass of Earth is 6.0×10^{24} kg, what is the linear speed of the satellite?

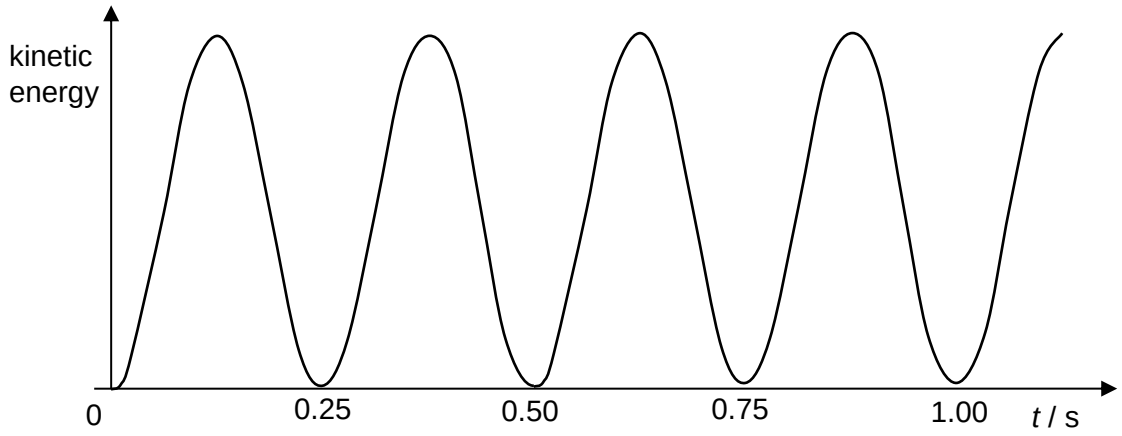
A 3080 m s^{-1}
B 1.71×10^5 m s^{-1}
C 4.23×10^7 m s^{-1}
D 2.75×10^{11} m s^{-1}

22 An object is set into free oscillations of amplitude 0.12 m. The oscillations are simple harmonic in nature with a period of T. At time t = 0 s, the object is at the equilibrium position.

What is the displacement at time $t = \frac{T}{8}$?

A 0.085 m
B 0.094 m
C 0.104 m
D 0.114 m

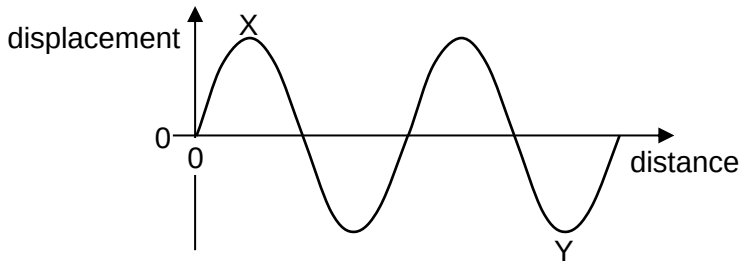
23 The variation of kinetic energy with time of a simple harmonic oscillation is as shown.



What is the angular frequency of the oscillations?

A 3.14 rad s^{-1}
B 6.28 rad s^{-1}
C 12.6 rad s^{-1}
D 25.2 rad s^{-1}

24 The displacement-distance graph for a transverse progressive wave is as shown.

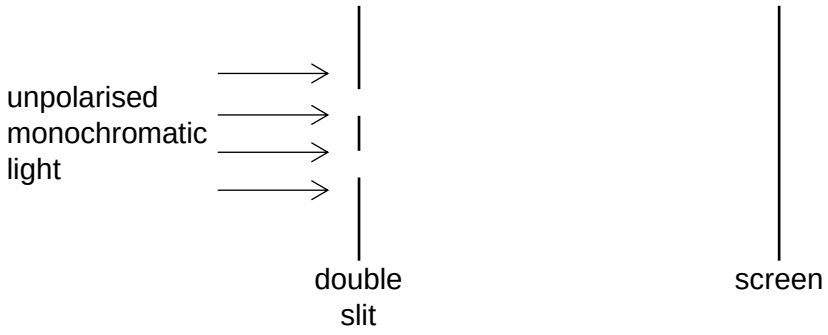


The phase difference between points X and Y can be expressed as $(180n)°$.

What is the value of *n*?

A 1.5
B 2.5
C 3.0
D 6.0

25 An interference pattern is successfully obtained on the screen using the set up as shown.

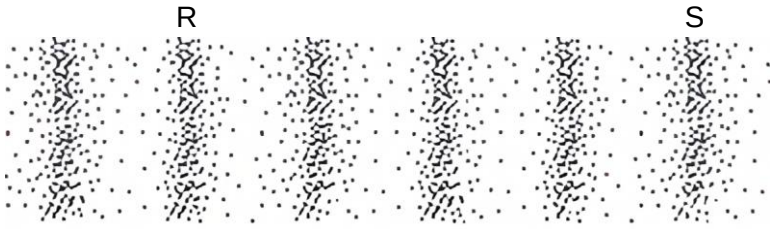


Each of the double slit is then completely covered by a linear polarizer. The linear polarizers are oriented such that the transmission axis are at 90° to each other.

What will be seen on the screen?

A a series of alternating bright and dark fringes that are equally spaced
B a central bright spot flanked by sharp, bright maxima
C a central bright maxima flanked by weaker maxima with alternating dark fringes
D a dark screen

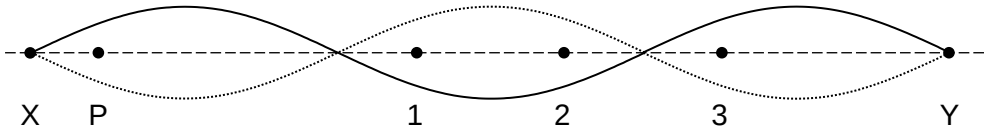
26 A sound wave of frequency 50 Hz propagates through air at a speed of 350 m s^{-1}. The spatial distribution of the gas particles in air at an instant is as shown.



What is the distance between R and S?

A 7.0 m
B 14 m
C 28 m
D 35 m

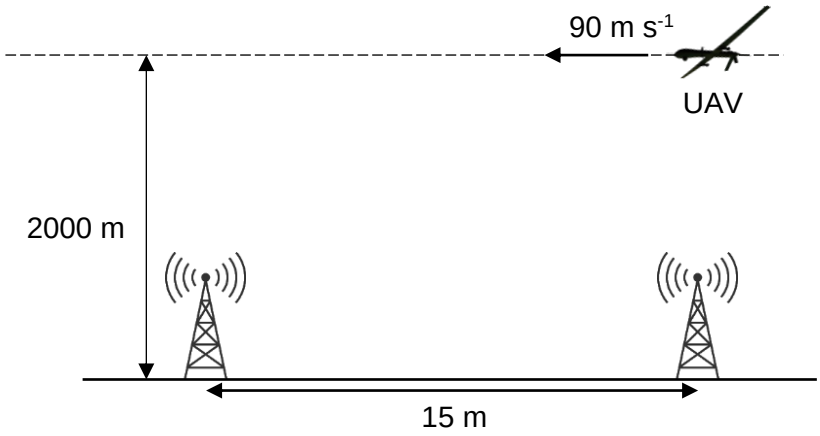
27 A standing wave is set up on a stretched string XY as shown.



At which point(s) will the oscillation be in anti-phase with that at P?

A 1 only
B 3 only
C 1 and 2
D 1, 2 and 3

28 Two radio antennas located 15 m apart are point sources of coherent sinusoidal radio waves of wavelength 3.0 cm. An unmanned aerial vehicle (UAV) flies by 2000 m above ground directly overhead along the line joining the two radio antennas.



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The resultant signal received by the UAV shows regular fluctuations in amplitude as the UAV flies at a constant ground speed of 90 m s^{-1}. What is the period of these fluctuations?

A 0.044 s
B 0.083 s
C 4.00 s
D 22.5 s

29 The average diameter of the pupil of the human eye is around 2.0 mm. On a bright sunny day, two white balls of the same diameter 20 cm are placed at a certain distance from each other. A person standing 10 km away is just able to distinguish the two balls.

What is the shortest possible distance of separation between the centres of the balls?

A 1.0 m
B 2.0 m
C 3.5 m
D 4.0 m

30 A monochromatic light source incident normally on a diffraction grating creates first order maxima at 30° from the central bright spot. The same light source produces interference fringes on a screen that is 1.5 m away from a pair of double-slits. The slit separation between the double-slit is 500 times longer than the line spacing of the grating.

What is the fringe separation on the screen when the double-slit experiment is performed?

A 0.0035 m
B 0.0025 m
C 0.0020 m
D 0.0015 m

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