RAFFLES INSTITUTION
2021 YEAR 5 TERM 3 COMMON TEST

30 June 2021 Time: 2 hr 30 min

H2 PHYSICS

Section A

INSTRUCTIONS TO CANDIDATES

There are 2 sections in this paper.

Section A consists of **15** multiple-choice questions. For each question, four suggested answers are given. You are to choose the most appropriate one and shade your answer on the OMR form, using a soft pencil.

You are advised to attempt Section A first. The **OMR form will be collected at the end of the first 30 minutes**.

Section B consists of **7** structured questions. You are to write your answers in the spaces provided.

Attempt ALL questions in Sections A and B.

This document consists of **10** printed pages.

Data

speed of light in free space	c	=	3.00×10^{8} m s^{-1}
permeability of free space	μ_0	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space	ε_0	=	8.85×10^{-12} F m^{-1}
		=	$(1/(36\pi)) \times 10^{-9}$ F m^{-1}
elementary charge	e	=	1.60×10^{-19} C
the Planck constant	h	=	6.63×10^{-34} J s
unified atomic mass constant	u	=	1.66×10^{-27} kg
rest mass of electron	m_e	=	9.11×10^{-31} kg
rest mass of proton	m_p	=	1.67×10^{-27} kg
molar gas constant	R	=	8.31 J K^{-1} mol^{-1}
the Avogadro constant	N_A	=	6.02×10^{23} mol^{-1}
the Boltzmann constant	k	=	1.38×10^{-23} J K^{-1}
gravitational constant	G	=	6.67×10^{-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	=	ρgh
gravitational potential	ϕ	=	$-Gm/r$
temperature	T/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	=	$v_0 \cos \omega t = \pm\omega\sqrt{x_0^2 - x^2}$
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	=	$\frac{Q}{4\pi\varepsilon_0 r}$
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	λ	=	$\ln 2 / t_{1/2}$

Section A (15 marks)

1 A ship sails northward with a constant speed v. After some time, it changes its course and sails in the north-west direction with the same speed v.

The change in velocity that has taken place in this time interval is

A $0.77v$ in a direction $112.5°$ anticlockwise from the original direction.

B $0.77v$ in a direction $67.5°$ clockwise from the original direction.

C $1.8v$ in a direction $22.5°$ anticlockwise from the original direction.

D $1.8v$ in a direction $157.5°$ clockwise from the original direction.

2 The diagram shows a regular-sized sugar-glazed donut.

Which of the following gives a reasonable estimate for the order of magnitude of the average density of the donut?

A 10^{-2} kg m^{-3} **B** 10 kg m^{-3} **C** 10^{2} kg m^{-3} **D** 10^{5} kg m^{-3}

3 Two stones, X and Y, of different masses are dropped from the top of a cliff. Stone Y is dropped a short time after stone X.

Neglecting air resistance, while the stones are falling, the distance between them will

A decrease if the mass of Y is greater than the mass of X.

B increase if the mass of Y is greater than the mass of X.

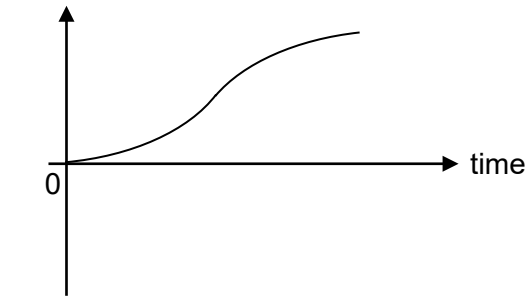
C decrease regardless of the masses of X and Y.

D increase regardless of the masses of X and Y.

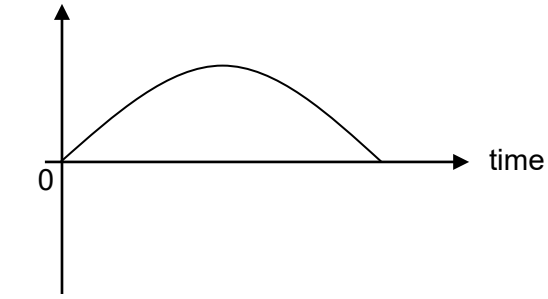
4 An object is thrown vertically upwards with an initial velocity and returns to its original position.

Which graph incorrectly shows the variation of the quantities of the object's motion?

A



B



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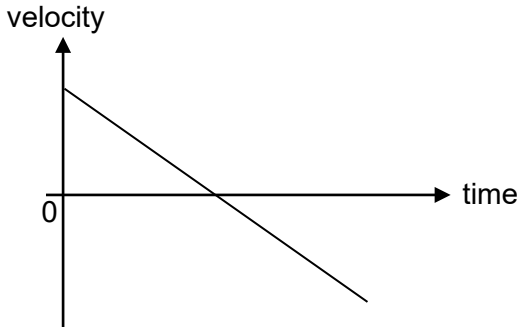
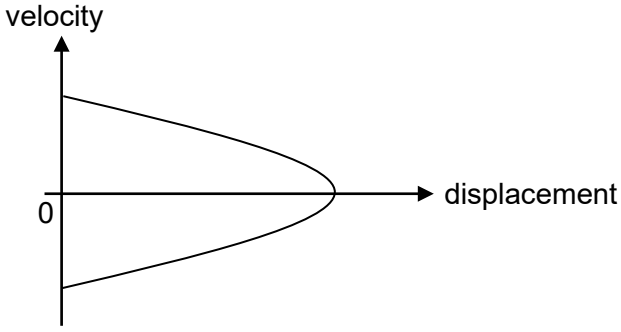


D

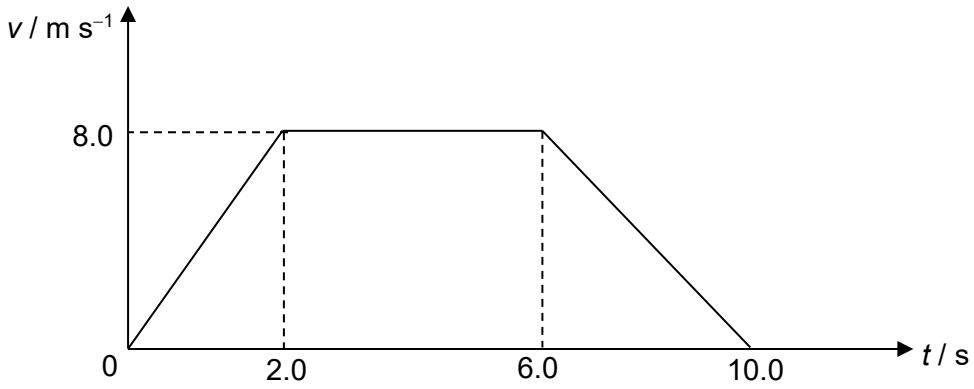


5 A car is travelling with uniform acceleration along a straight road. The road has marker posts every 100 m. When the car passes one post, it has a speed of 10 m s^{-1} and when it passes the next one, its speed is 20 m s^{-1}.

What is the acceleration of the car?

A 0.67 m s^{-2} **B** 1.5 m s^{-2} **C** 2.5 m s^{-2} **D** 6.0 m s^{-2}

6 A 62 kg passenger stands on a weighing scale in an elevator. The graph shows the variation with time t of the velocity v of the passenger when the elevator starts to move upwards at $t = 0$ s.



Which of the following statements is true?

A At $t = 1.0$ s, the reading on the weighing scale is 360 N.

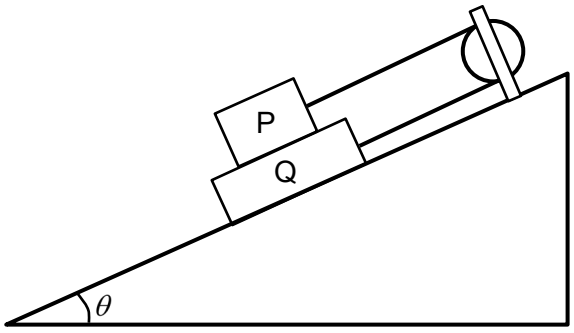
B At $t = 4.0$ s, the reading on the weighing scale is 0 N.

C At $t = 8.0$ s, the reading on the weighing scale is 484 N.

D At $t = 9.0$ s, the reading on the weighing scale is 732 N.

7 Two blocks P and Q of masses 100 g and 900 g respectively, are connected by a light rope strung over a smooth pulley on an inclined plane as shown.

The blocks are initially held in place by an external force. Upon removal of the external force, P accelerates upwards while Q accelerates downwards parallel to the plane at 3.0 m s^{-2}.



If the inclined plane is frictionless while the frictional force between the surfaces of P and Q is 0.10 N, what is the angle of inclination θ of the plane?

A 21° **B** 22° **C** 24° **D** 66°

8 Two stationary ice-skaters Charlie and Sam, each of mass 60 kg, are directly facing one another on an ice-skating rink.

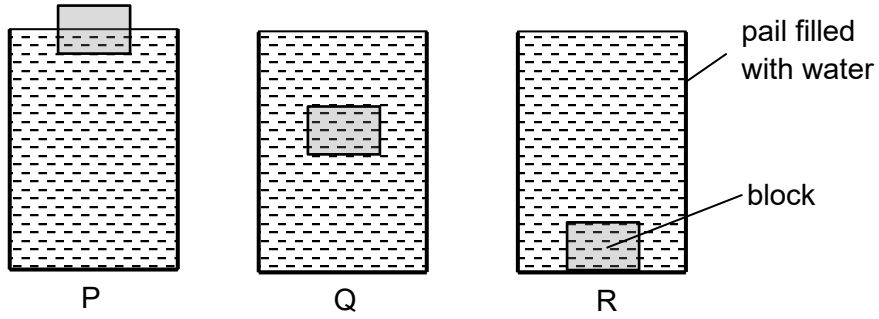
Charlie throws a 1.5 kg medicine ball towards Sam with a horizontal speed of 2.5 m s^{-1}. Sam catches the ball and throws it back to Charlie with the same horizontal speed.

The speed of Charlie after catching the ball is

A 0.061 m s^{-1} **B** 0.063 m s^{-1} **C** 0.12 m s^{-1} **D** 0.13 m s^{-1}

9 Three identical pails P, Q and R are filled to the brim with water. Three blocks of the same volume, but made of different materials, are placed into the pails.

The diagram shows the final positions of the three blocks.



Each pail is then separately placed on a weighing scale to determine their weights.

How do the weights of P, Q and R compare?

A weight of P = weight of Q = weight of R

B weight of P = weight of Q < weight of R

C weight of P < weight of Q = weight of R

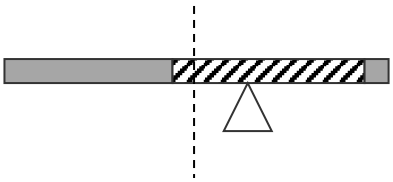
D weight of P < weight of Q < weight of R

10 Four different composite rods of uniform thickness are to be balanced horizontally on a pivot. Each rod is made of 50% material P and 50% material Q. Material Q is denser than material P.

In the diagrams below, the mid-point of each composite rod is indicated by a dotted vertical line.

Which diagram shows the position of the rod that is unlikely to be balanced?

A



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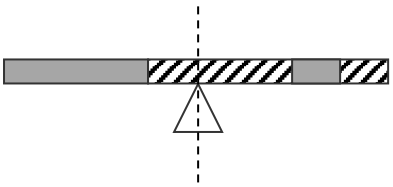

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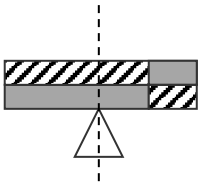
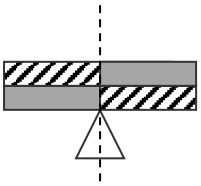
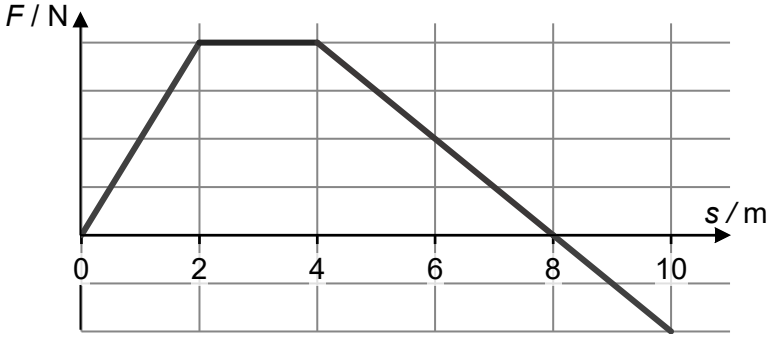


D

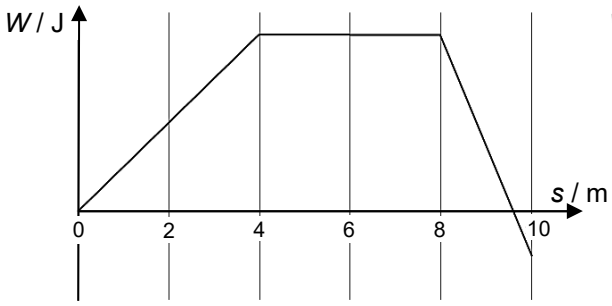


11 The graph shows the variation with the displacement *s* of an object of the force *F* applied to it.

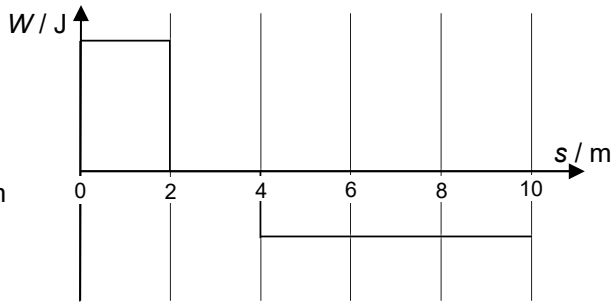


Which of the following graphs shows the variation with *s* of the work done *W* by *F* on the object?

A



B



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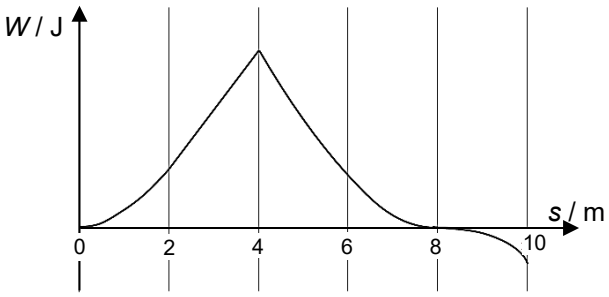

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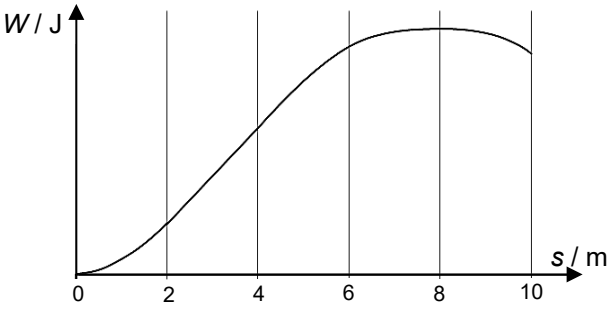
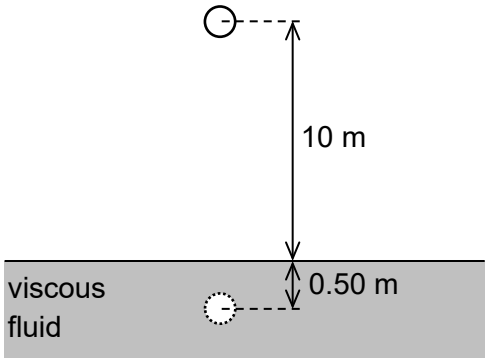


12 An object is released from rest at a height of 10 m above the surface of a viscous fluid. The mass of the object is 1.0 kg and the viscous fluid provides a constant retarding force of 160 N.



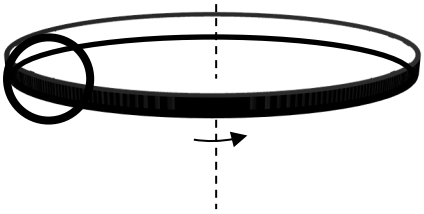
Assuming that air resistance and upthrust is negligible, what is the speed of the object after it has travelled 0.50 m into the viscous fluid?

A 3.4 m s^{-1} **B** 6.8 m s^{-1} **C** 14 m s^{-1} **D** 19 m s^{-1}

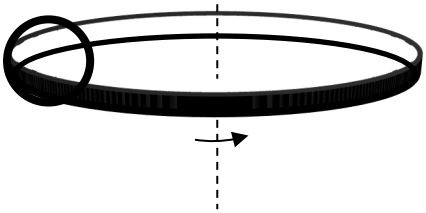
13 A small ring of mass *m* is threaded through a big ring. The big ring is then rotated about a vertical axis through its centre at a constant rate such that the small ring undergoes uniform circular motion in a horizontal plane.

Which diagram shows the position of the small ring when it is in circular motion?

A



B



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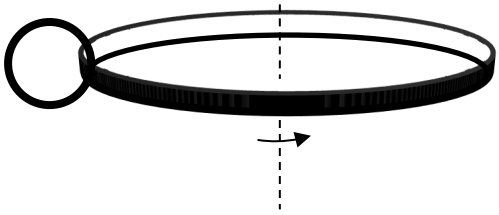

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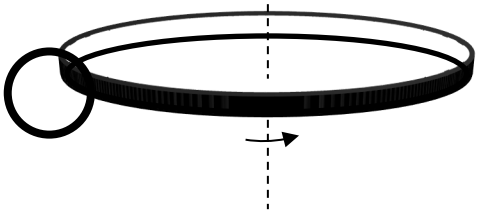
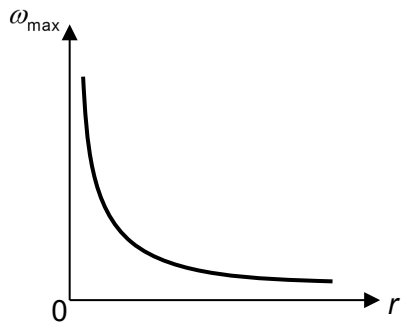


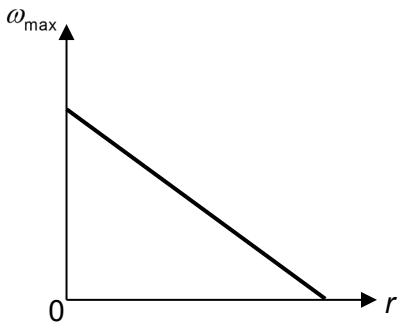
14 A coin is placed on a rough horizontal turntable at a distance *r* from the centre of the turntable. The turntable is rotated about the vertical axis through its centre. The largest possible angular velocity that the turntable can rotate without the coin sliding off is ω_{max}.

Which graph best represents the relationship between *r* and ω_{max}?

A



B



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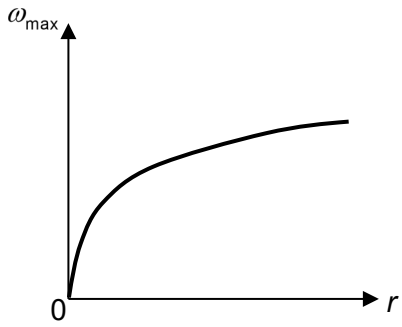
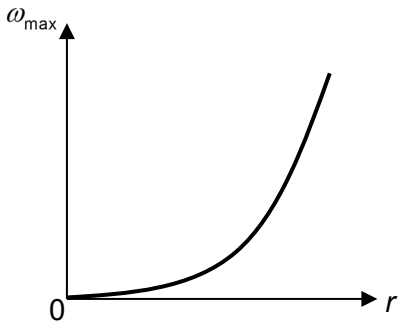
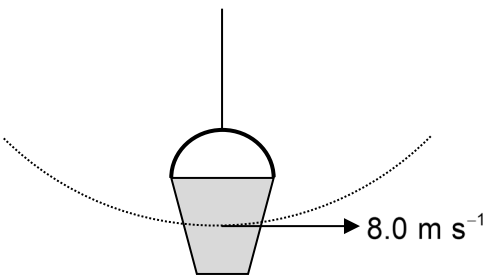


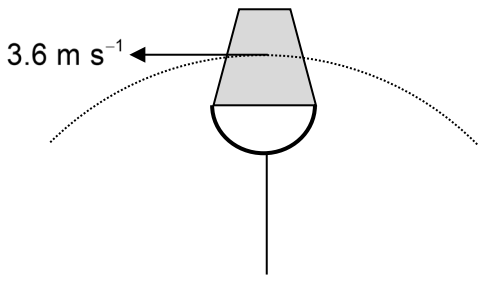
D



15 A bucket of mass 1.2 kg is held by a string and whirled in a vertical circle. The radius of the circle is 1.3 m. The speed of the bucket is 3.6 m s^{-1} at the top of the circle and 8.0 m s^{-1} at the bottom of the circle.



at the bottom of the circle



at the top of the circle

What is the difference in the tension in the string at these two positions?

A 34 N **B** 47 N **C** 71 N **D** 100 N

END OF SECTION A