Candidate's Name …… CTG ……

YISHUN JUNIOR COLLEGE

2014 JC 1 BLOCK TEST

PHYSICS 9646 / 1

HIGHER 2 **25 June 2014 Wednesday**

Paper 1 **40 minutes**

Additional Materials:
Optical Mark Sheet

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name and CTG on the Optical Mark Sheet in the spaces provided.
Shade your NRIC in the space provided.

There are **twenty** questions in 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 Optical Mark Sheet.

Read the instructions on the Optical Mark Sheet carefully.

INFORMATION FOR CANDIDATES

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.

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
permeability of free space,	μ_o	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_o	=	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	=	$\rho g h$
gravitational potential,	ϕ	=	$-\frac{Gm}{r}$
Displacement of particle in s.h.m.	x	=	$x_o \sin \omega t$
velocity of particle in s.h.m.,	v	=	$v_o \cos \omega t$
		=	$\pm \omega \sqrt{(x_o^2 - x^2)}$
resistors in series,	R	=	$R_1 + R_2 + \ldots\ldots$
resistors in parallel,	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots$
electric potential,	V	=	$\frac{Q}{4\pi\varepsilon_o r}$
alternating current/voltage,	x	=	$x_o \sin \omega t$
transmission coefficient	T	=	$\exp(-2kd)$
where k		=	$\sqrt{\frac{8\pi^2 m(U-E)}{h^2}}$
radioactive decay,	x	=	$x_o \exp(-\lambda t)$
decay constant,	λ	=	$\frac{0.693}{t_{\frac{1}{2}}}$

1 A student determined the density of a spherical steel ball by measuring its mass and diameter. The mass and diameter were measured to an accuracy of 1 % and 2 %, respectively. The student's error in the calculated density of the steel ball is at most

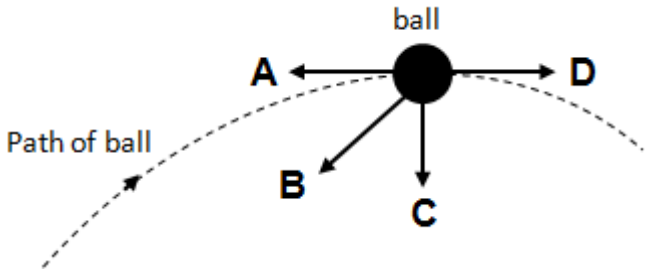
A 3 % **B** 4 % **C** 5 % **D** 7 %

2 A car, of mass 1000 kg, initially moves eastwards at 5.00 m s^{-1}. It then changes direction to southwards, keeping its speed the same. Determine the change in momentum, Δp, of the car.

	Magnitude of Δp / N s	Direction of Δp
A	7070	south-westwards
B	7070	north-eastwards
C	0	none
D	7070	south-eastwards

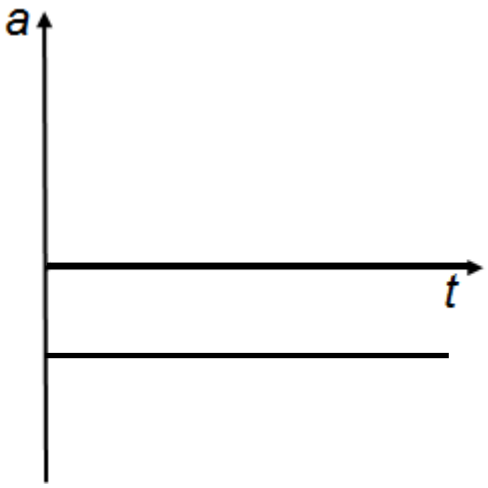
3 A ball is thrown at an angle and it experiences air resistance while in flight.

What would be the direction of the resultant force on the ball at its maximum height as shown below?

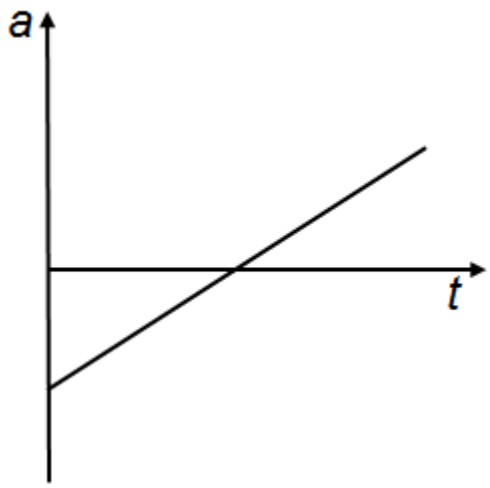


4 A stone is thrown vertically upwards. It reaches a maximum height and then falls to the ground. Air resistance is negligible.
Which of the following graph shows the variation with time *t* of the acceleration *a* experienced by the stone?

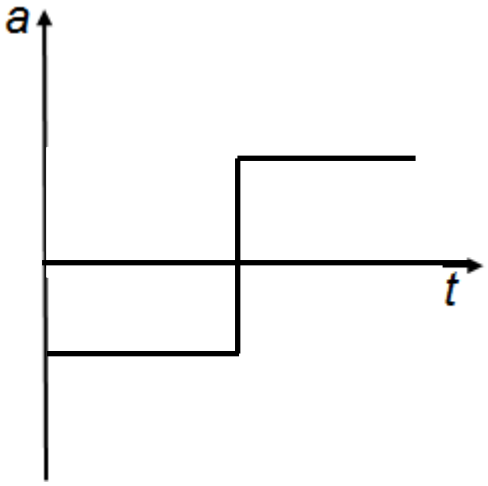
A



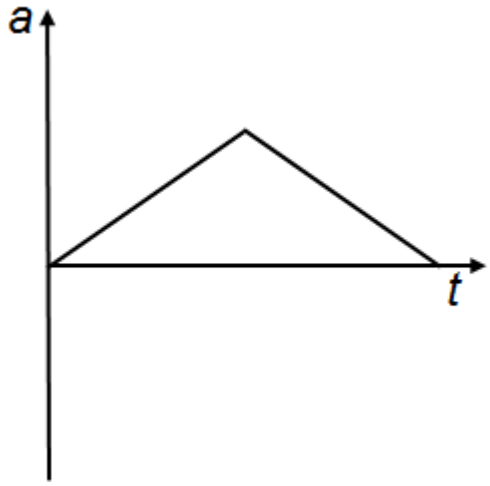
B



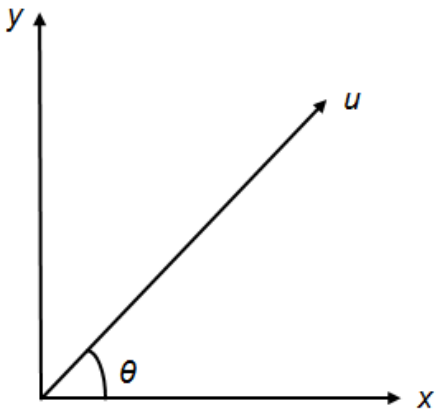
C



D



5 In the absence of air resistance, a cannonball is fired with an initial velocity *u* at an angle *θ* to the horizontal.



After time *t*, what is the vertical displacement *y*, and horizontal displacement *x*, in terms of *u*, *θ, t, and g,* the acceleration due to gravity?

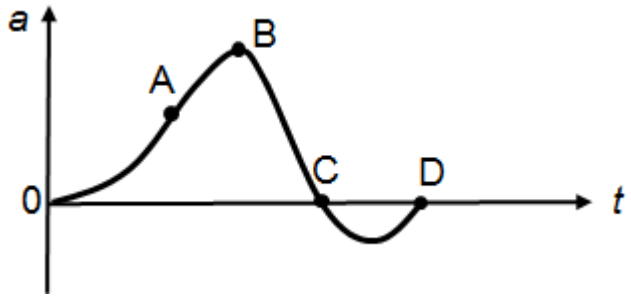
A $y = utcos\theta - \frac{1}{2}gt^2, x = utsin\theta$

B $y = utsin\theta - \frac{1}{2}gt^2, x = utcos\theta$

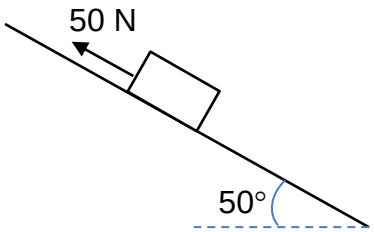
C $y = utsin\theta - \frac{1}{2}gt^2, x = utcos\theta + \frac{1}{2}gt^2$

D $y = utcos\theta + \frac{1}{2}gt^2, x = utcos\theta$

6 A car starts moving from rest and is travelling along a straight road. The graph shows the variation with time, *t*, of its acceleration, *a*, during the journey. At which point on the graph does the car have its greatest displacement?

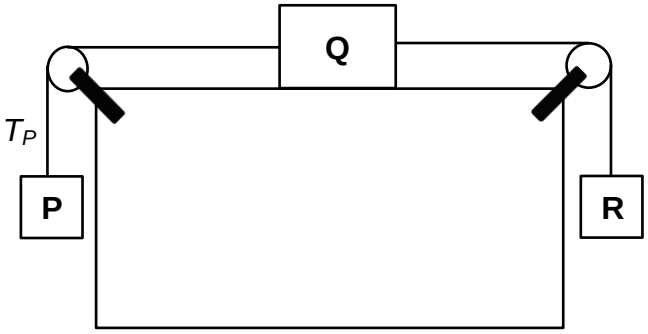


7 A 7.0 kg box is moving along a rough slope at an angle of 50° to the horizontal. A force of 50 N is acting on it in the direction up the slope. The frictional force acting between the slope and the box is 2.0 N. Determine the acceleration of the box.



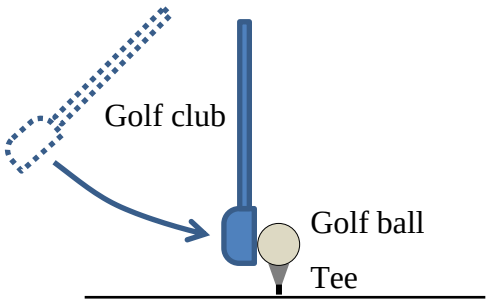
A 0.086 m s^{-2} **B** 0.55 m s^{-2} **C** 0.66 m s^{-2} **D** 1.1 m s^{-2}

8 Three blocks **P**, **Q** and **R** have masses of 1.0 kg, 2.0 kg and 3.0 kg respectively. If the horizontal surface on which block **Q** rests is frictionless, and the system is assumed to start from rest, determine tension T_P in the string connected to block **P**.



A 9.8 N **B** 13 N **C** 15 N **D** 21 N

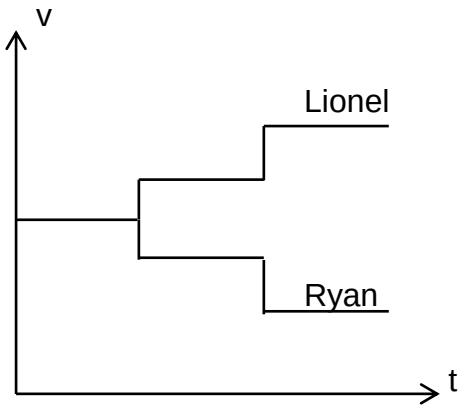
9 Immediately after being driven off a tee by a golf club, a 45 g golf ball leaves the club face with a velocity of 80 m s^{-1}. If the time of impact between the club and ball is 10 ms, determine the average force developed between the club and the ball during impact



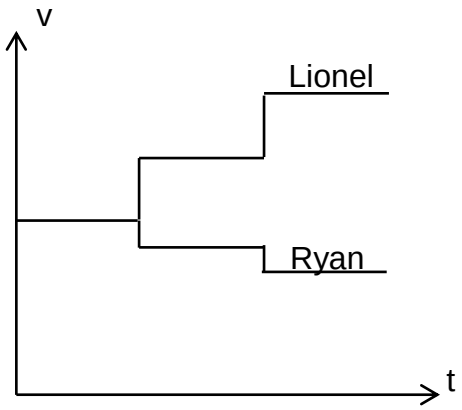
A 100 N **B** 200 N **C** 360 N **D** 440 N

10 Ryan and Lionel are on roller skates travelling to the right with the same velocity and Lionel is ahead of Ryan. Ryan is facing rightward, while Lionel is facing leftward. Ryan passes a basketball to Lionel and subsequently Lionel passes the basketball back to Ryan with the same speed. Assuming that the passing of the basketball is instantaneous and that Ryan is heavier than Lionel, which velocity-time (v-t) graph correctly represents the variation in their velocity?

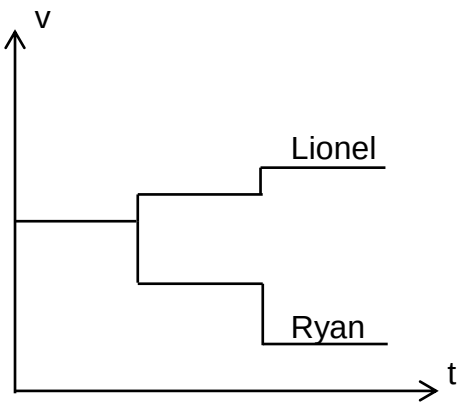
A



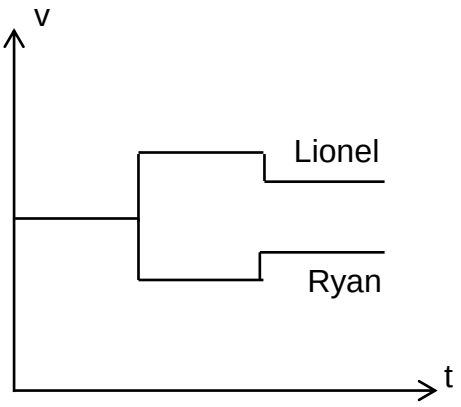
B



C

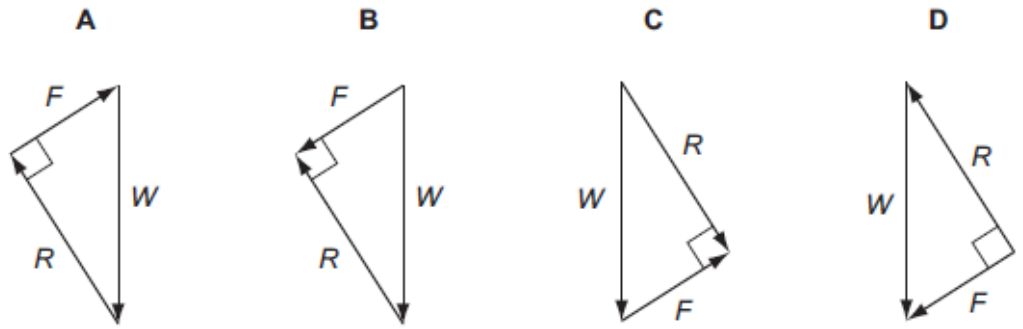


D

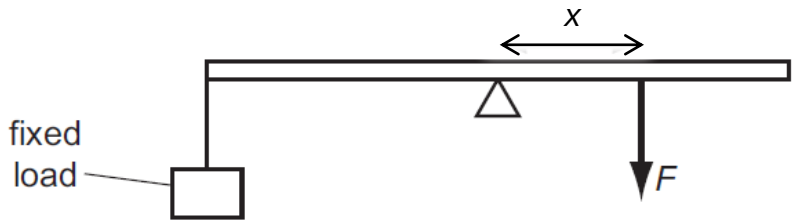


11 A vehicle is at rest on a slope. It is considered to have 3 forces acting on it to keep it in equilibrium. They are its weight, *W*, a normal reaction force *R* and a frictional force *F*.

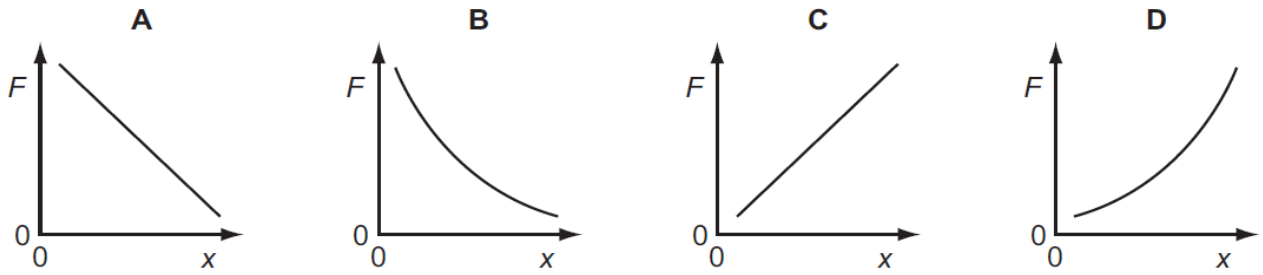
Which triangle of forces is correct?



12 A horizontal bar is supported on a pivot at its centre of gravity. A fixed load is attached to one end of the bar. To keep the bar in equilibrium, a force *F* is applied at a distance *x* from the pivot.



How does *F* vary with *x*?



13 A cylindrical block of metal has cross-sectional area A and weight W. It is totally immersed in water with its axis vertical. The block experiences pressures p_t and p_b at its top and bottom surfaces respectively.

Which expression is equal to the upthrust on the block?

A $(p_b - p_t)\,A + W$

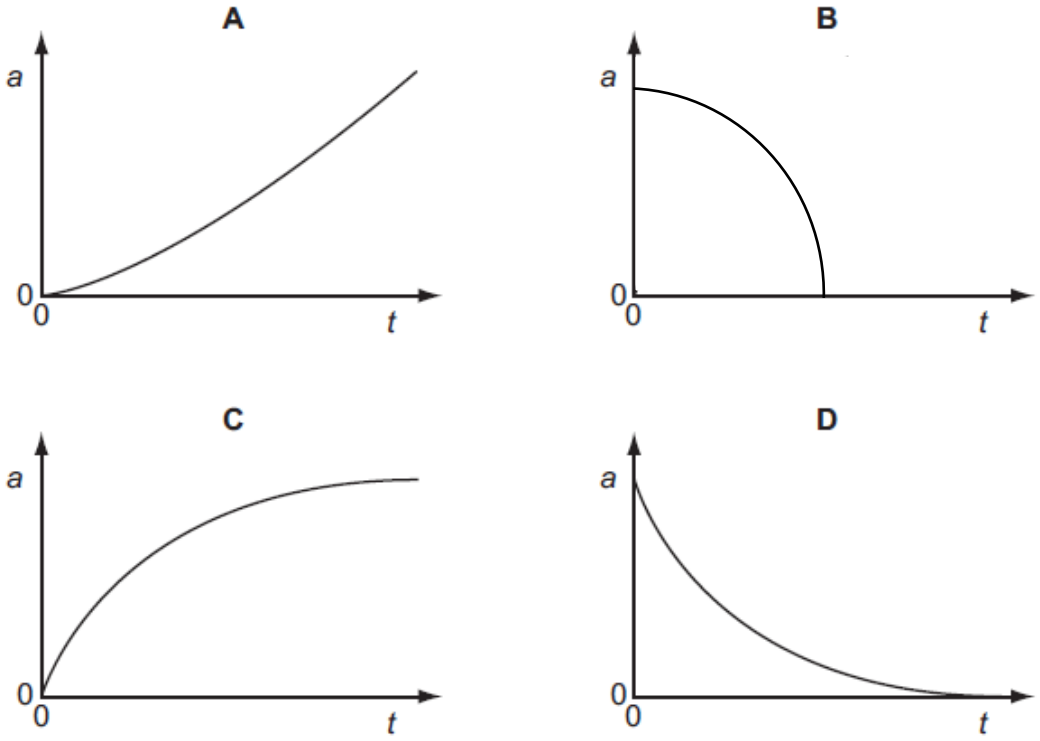
B $(p_b - p_t)$

C $(p_b - p_t)\,A$

D $(p_b - p_t)\,A - W$

14 A metal sphere is released from rest in a viscous fluid.

Which graph represents the variation with time t of the acceleration a of the sphere?



15 A marble is falling at terminal speed in still air. The forces acting on the marble are upthrust, viscous drag and weight.

How do the relative magnitudes of the three forces compare?

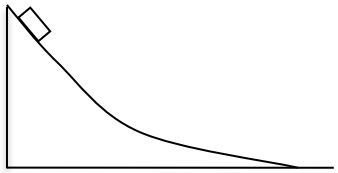
A upthrust < viscous drag < weight

B viscous drag < upthrust < weight

C viscous drag < weight < upthrust

D weight < upthrust < viscous drag

16 A block of 30 kg is released from rest at a height of 2.00 m above the ground. It then travels a distance of 5.00 m along a curved slope to the ground as shown in the figure below. The final speed of the block at the end of the slope is only 1.50 m s^{-1} because a constant frictional force acts on it during the descent.



What is the frictional force acting on the block?

A 5.25 N **B** 111 N **C** 124 N **D** 559 N

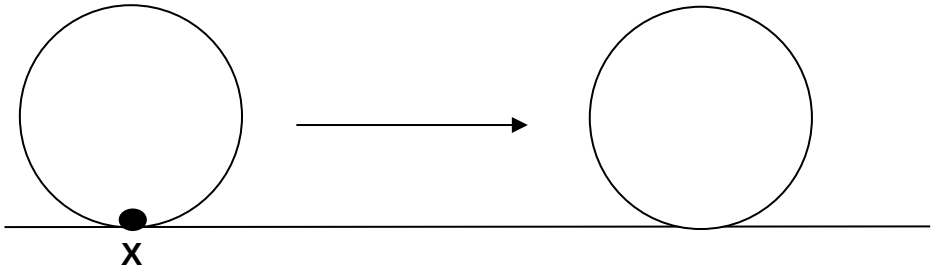
17 A wire which obeys Hooke's Law has an unstretched length l_0. It is first stretched to a length l_1. It is then relaxed and subsequently stretched to a length l_2. What is the ratio of the energy stored in the wire in stretching it to l_2, to the energy stored in the wire in stretching it to l_1?

A $\left(\frac{l_2}{l_1}\right)^2$ **B** $\left(\frac{l_2 - l_0}{l_1 - l_0}\right)^2$ **C** $\frac{l_2}{l_1}$ **D** $\frac{l_2 - l_0}{l_1 - l_0}$

18 A motor raises a weight of 7.5 N at constant acceleration of 2.0 m s^{-2} through a vertical height 80 cm in 2.0 s. The efficiency of the motor is 20%. What is the electrical power supplied to the motor?

A 0.60 W **B** 6.0 W **C** 15 W **D** 18 W

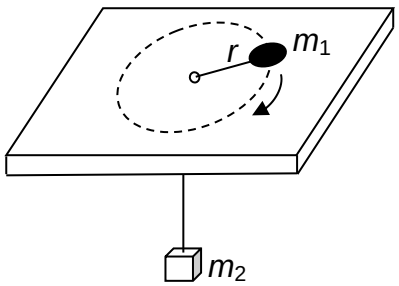
19 A cylinder of radius 10.0 cm started rolling along a surface from left to right at a constant angular velocity of 0.75π rad s^{-1}. The cylinder has a point marked with a **X**, located at the bottom of the cylinder at the start.



What will be the displacement of **X** after 4.00 s?

A 0.020 m **B** 0.150 m **C** 0.942 m **D** 0.963 m

20 The diagram shows two masses, m_1 and m_2 connected by a string. Mass m_1, of 0.50 kg, is made to revolve in a circle of radius r on a frictionless horizontal table with a speed of 2.0 m s^{-1}. Mass m_2, of mass 0.80 kg, is tied to the other end of the string and suspended below, through a hole in the table.

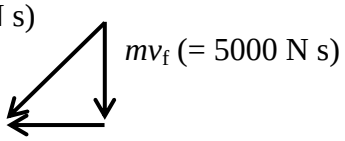


What is the value of the radius r such that m_2 does not rise nor fall?

A 0.25 m **B** 0.33 m **C** 0.41 m **D** 0.65 m

– End of paper –

2014 JC1 BT H2 Physics Paper 1 MCQs Solution:

S/N	Answer	Explanation
1	D	$D = \frac{m}{V} = \frac{m}{\frac{4}{3}\pi(d/2)^3}$ Thus, $\frac{\Delta D}{D} = \frac{\Delta m}{m} + 3\frac{\Delta d}{d}$ = … = 0.07
2	A	$\therefore \Delta mv$ (= 7070 N s)  mv_f (= 5000 N s) $-mv_i$ (= 5000 N s)
3	B	At the peak of trajectory, only horizontal velocity is present →horizontal air resistance force present acting against horizontal motion. Superposed with vertical force due to gravity, resultant force is given by B.
4	A	Only acceleration due to gravity is present throughout the motion. It is constant at 9.81ms^{-2}
5	B	Using $s = ut + \frac{1}{2}at^2$, the answer could be obtained where a = - g.
6	D	While the acceleration changes direction, the velocity has not. This could be deduced since the area of the graph in the negative region is lesser than that in the positive region. The displacement is thus greatest at the end of the journey.
7	A	In comparing the component of weight along slope (7*9.91*sin50° = 52.604 N) and the upslope force (50N), it can be deduced that the object will be accelerating downslope (even with the friction of 2 N factored in to oppose the motion) Thus, 52.604 – 50 – 2 = 7a a = 0.086 m s^{-2}
8	B	Taking P, Q & R as system, $\sum F = ma$ $(3.0-1.0)\times 9.81 = (1.0+2.0+3.0)a$ $a = 3.27$ m s^{-2} Taking P as system, $\sum F = ma$ $T_P - 1.0\times 9.81 = 1.0\times 3.27$ $T_P = 13$N

9 **C** Using Impulse = change in momentum,

Average force × time = final p – initial p

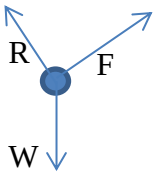
F × 0.001 = (0.045)*(80) – 0

F = 360 N

10 **B** Given that they pass the basketball back and forth with the same speed implies each time the ball is passes, there is an equal change in magnitude of momentum.

However, since the graph is v-t rather than p-t, the gain in velocity by Lionel is greater since he has lesser mass. Thus each pass of the ball would result in the same magnitude of increase for velocity of Lionel, whereas Ryan would lose equal amounts (of lesser magnitude since he is more massive) of velocity.

11 **A**



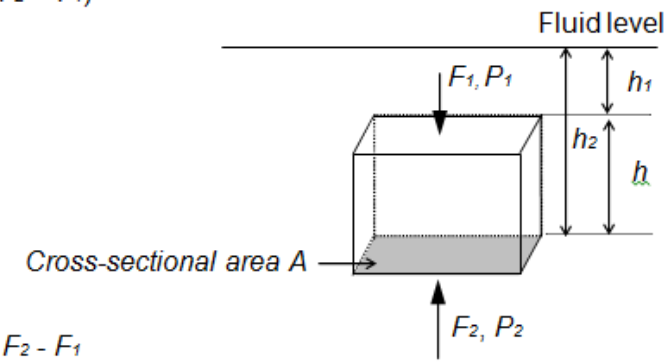
12 **B** Assume the distance between pivot and load(W), y remains unchanged,

By taking moments about pivot,

W (y) = F x

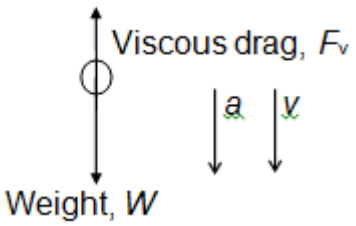
F = (Wy)/x , hence F α 1/x

13 **C** The upthrust is caused by pressure difference, $P_2 - P_1$, which in tum causes a difference in force (= $F_2 - F_1$)



Upthrust = $F_2 - F_1$
= $P_2A - P_1A$

14 **D**

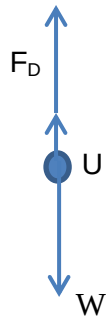


(Teachers may want to emphasise the relative lengths of the Fv and W arrows.)

As body falls from rest, v increases, hence F_v increase (since $F_v \propto v$)

As $W - F_v = ma, a = \frac{W}{m} - \frac{kv}{m}$, *a* follows the graph in D.

15 **A** At terminal velocity, the net force is zero.



Upthrust of marble due to air is very small in magnitude as density of air is low and marble has a small volume.

16 **B** Using Principle of Conservation of Energy

Loss in GPE = Gain in KE + Work done against friction

$$mgh = \frac{1}{2}mv^2 + Fs$$

$$30 \times 9.81 \times 2.00 = \frac{1}{2} \times 30 \times 1.50^2 + F \times 5.00$$

F=111 N

17 **B**

$$EPE = \frac{1}{2}kx^2$$

$$\frac{EPE_2}{EPE_1} = \frac{(l_2 - l_o)^2}{(l_1 - l_o)^2}$$

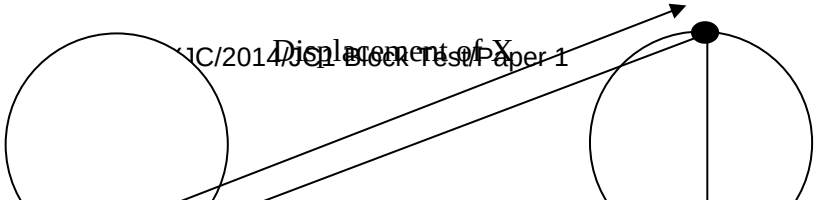
18 **D**

$$P = \frac{mgh}{t} + \frac{\frac{1}{2}m(v^2 - u^2)}{t} = \frac{7.5 \times 0.8}{2.0} + \frac{1}{2} \times \frac{7.5}{9.81} \times \frac{2 \times 2.0 \times 0.80}{2.0} = 3.61\,\text{W}$$

$[v^2 = u^2 + 2as]$

$$\frac{P_{out}}{P_{in}} \times 100 = 20 \qquad P_{in} = 18.1\,\text{W}$$

19 **D**



To determine horizontal displacement

Horizontal distance travelled = $[(\frac{3}{4}\pi \times 4) / 2\pi] \times 2\pi r = 0.942$ m

OR Horizontal distance travelled = $v\,t = (r\,\omega)\,t = 0.1 \times 0.75\pi \times 4$

To determine vertical displacement

Angular displacement after 4.00 s = $\frac{3}{4}\pi \times 4$ = 3π rad
No. of turns after 4.00 s = 3π / 2π = 1.5
Thus **X** is at the highest point
$\Rightarrow$ vertical height after 4.00 s = 2*r* = 0.200 m

To determine resultant displacement

Displacement of **X** = $\sqrt{0.942^2 + 0.200^2} = 0.963$ m

20 **A**

Taking m_1 as the system,

$F_{net} = ma_c$

$T = m_1\left(\frac{v^2}{r}\right)$ --- (1)

The tension in the string provides the centripetal force for m_1. It also counters the weight of m_2

Taking m_2 as the system,

$(\uparrow) F_{net} = ma$

$T - W = 0$

$T = m_2 g$ --- (2)

Thus, (1) = (2)

$m_2 g = m_1\left(\frac{v^2}{r}\right) \Rightarrow r$ = … = 0.25 m