Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Mid Year Examination
Year 5

H2 PHYSICS

9749

9 July 2019

2 hours

Multiple Choice and Structured Questions

Additional Materials:

Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

Section A

There are **fifteen** questions in this section.
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.

Section B

Answer **all** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
MCQ	**15**
Section B	
1	**10**
2	**10**
3	**16**
4	**10**
5	**5**
6	**9**
s.f.	**-1**
Total	**75**

Data

speed of light in free space	c	=	$3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
permeability of free space	μ_0	=	$4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space	ε_0	=	$8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
			$(1/(36\pi)) \times 10^{-9}\ \mathrm{F\,m^{-1}}$
elementary charge	e	=	$1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant	h	=	$6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant	u	=	$1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron	m_e	=	$9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton	m_p	=	$1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant	R	=	$8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant	N_A	=	$6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
the Boltzmann constant	k	=	$1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$
gravitational constant	G	=	$6.67 \times 10^{-11}\ \mathrm{N\,m^{2}\,kg^{-2}}$
acceleration of free fall	g	=	$9.81\ \mathrm{m\,s^{-2}}$

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	=	$-\frac{Gm}{r}$
temperature	T / K	=	T / °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	λ	=	$\frac{\ln 2}{t_{\frac{1}{2}}}$

Section A

Answer **all** the questions.

You are advised not to spend more than 30 minutes on Section A.

1. Which estimate is realistic?

A The mean kinetic energy of a typical saloon car traveling on an expressway in Singapore is 300 kJ.

B The density of a tennis ball is 30 g cm^{-3}.

C The power of a hair dryer is 10 kW.

D The pressure of air in a car tyre is 2×10^3 Pa.

2. Students A, B, C and D, each made a series of measurements of the acceleration of free fall, *g*. The table shows the results obtained.

Which student obtained a set of results that could be described as precise but not accurate?

Student	Results, g / m s^{-2}			
A	9.79	9.83	9.84	9.81
B	8.46	8.45	8.41	8.50
C	8.76	9.45	9.21	8.99
D	9.81	10.12	8.94	9.89

3 An aeroplane travels at an average speed of 600 km h^{-1} on an outward flight and at 400 km h^{-1} on the return flight over the same distance.

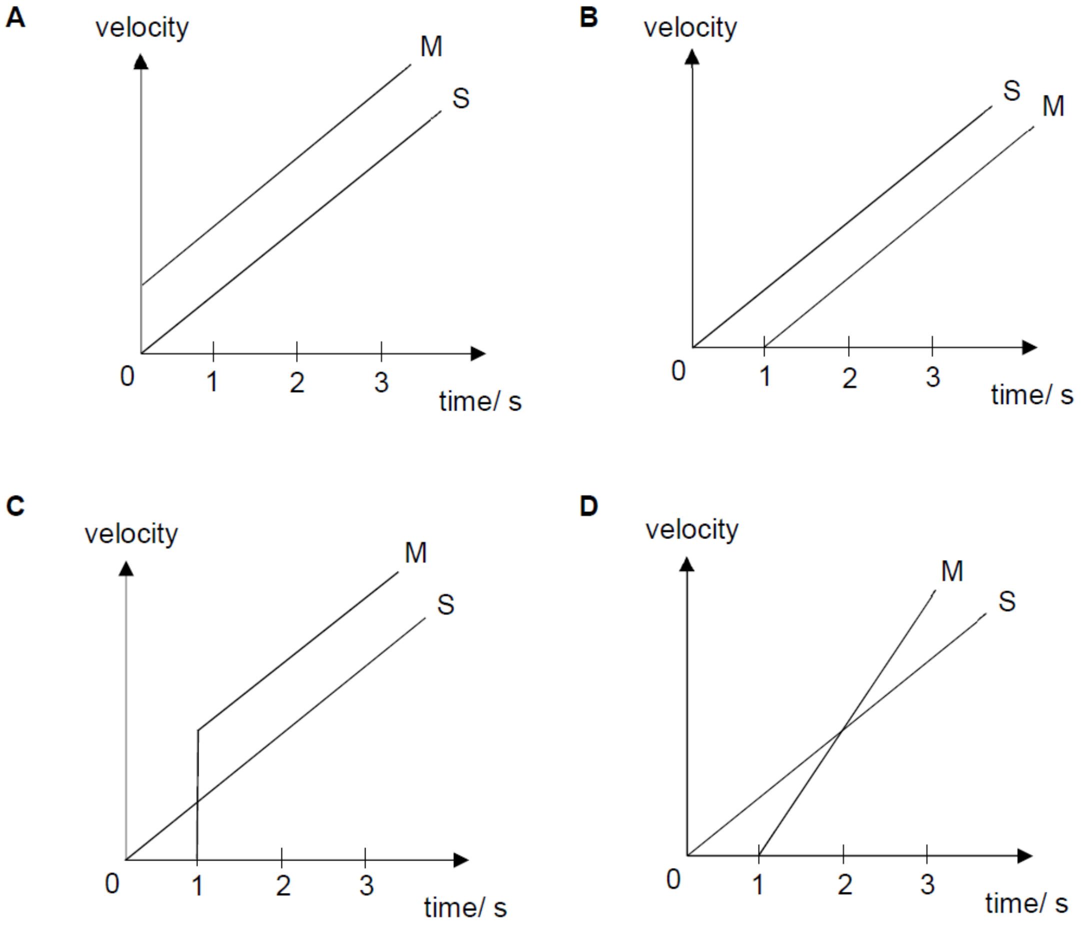
What is the average speed of the whole flight?

A 111 m s^{-1} **B** 167 m s^{-1} **C** 480 km h^{-1} **D** 500 km h^{-1}

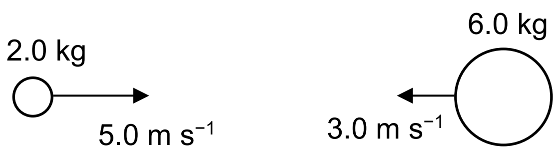
4 A man standing at the top of a building releases a stone from rest. One second later, he throws a marble vertically downward with an initial velocity.

Which of the following graphs best represents the velocity-time graphs for the stone (S) and the marble (M)?

Ignore the effects of air resistance.



5 Two masses make an elastic collision.



What are their speeds after the collision?

	2.0 kg mass	**6.0 kg mass**
A	2.0 m s^{-1}	4.0 m s^{-1}
B	4.0 m s^{-1}	6.0 m s^{-1}
C	5.0 m s^{-1}	3.0 m s^{-1}
D	7.0 m s^{-1}	1.0 m s^{-1}

6 A man is standing on a weighing scale in a lift.

Which of the following statements is **always** true?

A When the lift is moving down, the reading on the weighing scale is greater than the weight of the man.

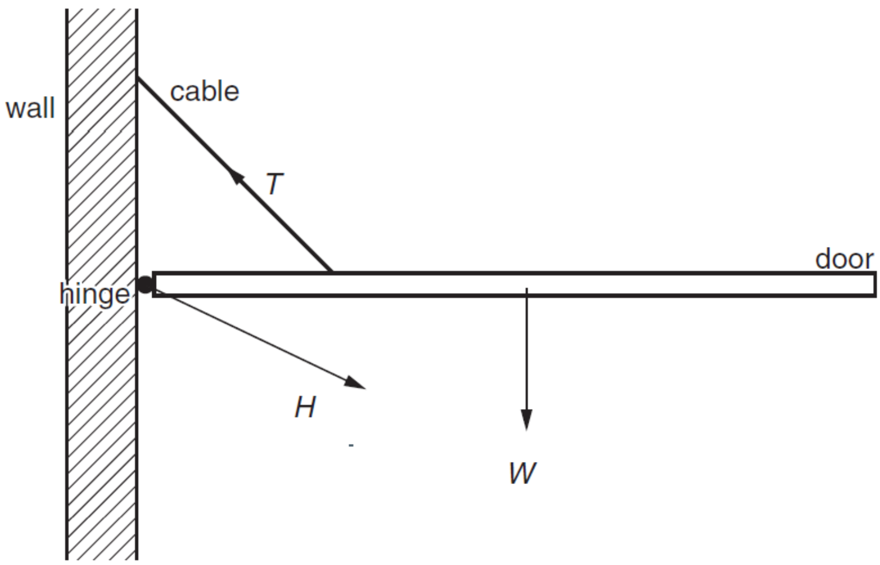
B When the lift is moving up, the reading on the weighing scale is greater than the weight of the man.

C The weight of the man is equal in magnitude and opposite in direction to the normal contact force acting on him due to Newton's third law of motion.

D The weight of the man is equal in magnitude to the force that he exerts on Earth.

7 A hinged door is held closed in the horizontal position by a cable.

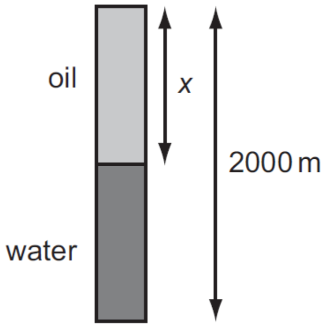
Three forces act on the door: the weight W of the door, the tension T in the cable, and the force H at the hinge.



Which list gives the three forces in **increasing** order of magnitude?

A H,T,W **B** T,H,W **C** W,H,T **D** W,T,H

8 A bore hole of depth 2000 m contains both oil and water as shown. The pressure at the bottom is 17.5 MPa. The density of the oil and water are 830 kg m^{-3} and 1000 kg m^{-3} respectively.



What is the depth *x* of the oil?

A 907 m **B** 1000 m **C** 1090 m **D** 1270 m

9 A bungee jumper has 24 kJ of gravitational potential energy at the top of his jump. He is attached to an elastic rope which starts to stretch after a short time of free fall. The values of gravitational potential energy, elastic potential energy and kinetic energy are given for the top and the bottom of the jump.

	gravitational potential energy / kJ	elastic potential energy / kJ	kinetic energy / kJ
top	24	0	0
bottom	0	24	0

Which row of the table below shows possible values of these three energies when the jumper is half-way down? Losses of energy through air resistance are negligible.

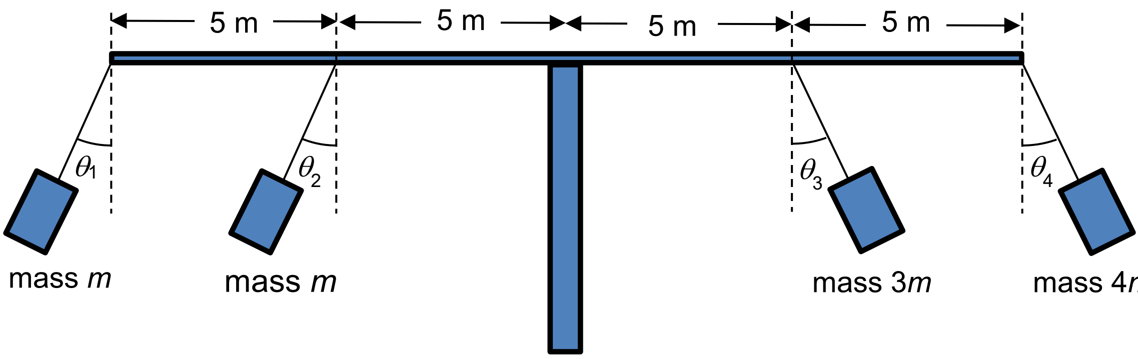
	gravitational potential energy / kJ	elastic potential energy / kJ	kinetic energy / kJ
A	12	2	10
B	12	8	4
C	8	8	8
D	12	10	2

10 A driving force of 200 N is needed for a car of mass 800 kg to travel along a level road at a speed of 20 m s^{-1}.

What power is required to maintain the car at this speed up a gradient in which the car rises 1 m for each 8 m travel along the road?

A 6.0 kW **B** 7.2 kW **C** 20 kW **D** 24 kW

11 In an amusement park, a horizontal metal beam of length 20 m is spun about its midpoint while park-goers of various masses are seated in identical light harnesses at varying distances from the midpoint as shown. At a steady angular velocity, the park-goers will be tilted at fixed angles from the vertical.



(not to scale)

Which of the following correctly describes the angles?

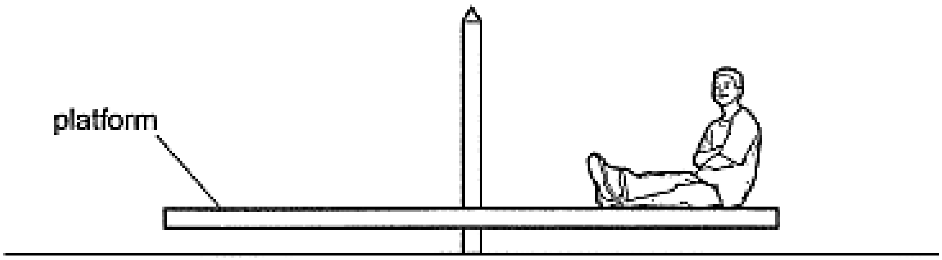
A $\theta_1 = \theta_2 = \theta_3 = \theta_4$

B $\theta_2 > \theta_3 > \theta_4$

C $\theta_2 = \theta_3$, $\theta_1 > \theta_2$

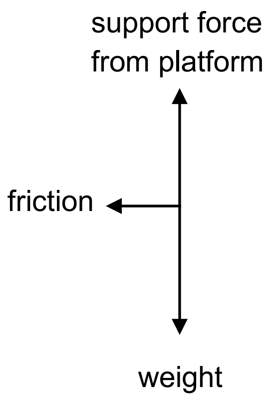
D $\theta_4 = 4\sin\theta_1$

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

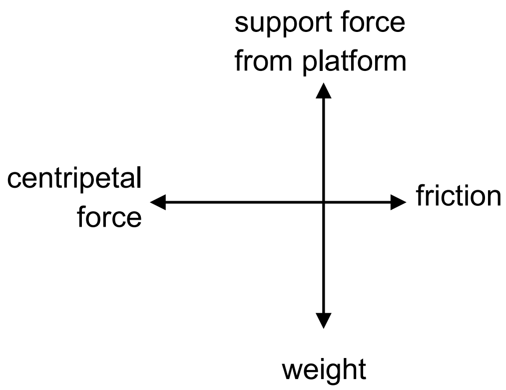


Which diagram shows the forces acting on the child when in the position shown?

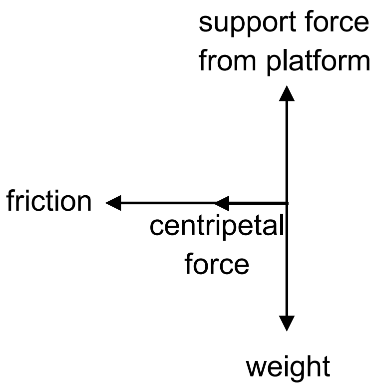
A



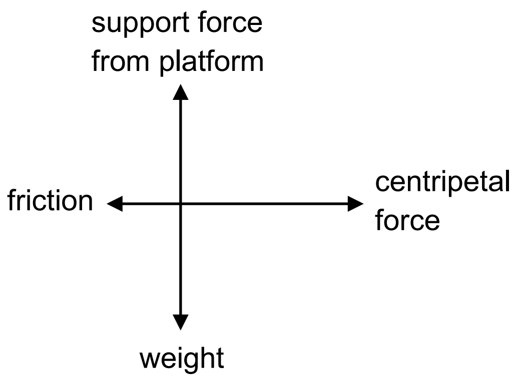
B



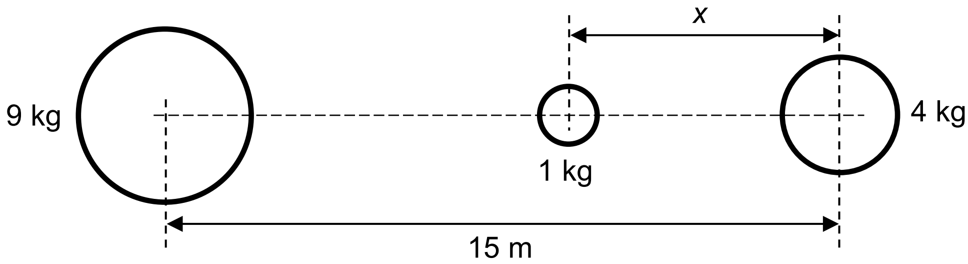
C



D



13 Three uniform masses are in a row, with their centres along a straight line as shown.



What is the distance, *x*, in metres, if the net force acting on the 1 kg mass is zero?

A 4.6 **B** 6.0 **C** 7.5 **D** 9.0

14 A small mass is initially at a distance *d* from the centre of a planet, where *d* is greater than the radius of the planet.

It takes work *W* to move the mass from distance *d* to a distance 2*d* from the centre of the planet.

What is the work required to move it from 2*d* to 3*d*?

A $\frac{W}{6}$ **B** $\frac{W}{3}$ **C** $3W$ **D** $6W$

15 A communication satellite which takes 24 hours to complete one orbit is replaced by a new satellite which has twice the mass of the first.

If the new satellite also has an orbit of 24 hours, what is the value of the ratio

$$\frac{\text{radius of orbit of new satellite}}{\text{radius of orbit of old satellite}}$$

A 1 : 2 **B** 1 : 1 **C** $\sqrt{2}$: 1 **D** 2 : 1

Section B
Answer **all** the questions.

You are advised not to spend more than 1 hour and 30 minutes on Section B.

1 In describing the forces acting on a sphere falling under gravity through a medium of liquid, Aloysius writes down the following equation:

$$6\pi\eta r v^2 = \frac{4}{3}\pi r^3(\rho - \rho_L)g$$

whereby

r is the radius of the sphere,
v the velocity,
g the acceleration of free fall,
η the coefficient of viscosity of the liquid with units: kg m^{-1} s^{-1},
ρ and ρ_L the densities of the sphere and the liquid respectively.

(a) By checking the homogeneity of the equation, deduce whether the equation is correct. [3]

(b) With turbulence set up in the liquid, Aloysius also discovered that the drag force F experienced by the sphere is given by the expression:

$$F = Br^2\rho v^2$$

where B is a constant which does not have a unit.

In an experiment involving the motion of the sphere through a liquid, Aloysius obtained the following set of data:

F = (8.0 ± 0.1) mN
r = (3.0 ± 0.1) cm
ρ = (1.00 ± 0.01) × 10^3 kg m^{-3}
v = (24 ± 1) cm s^{-1}

(i) Suggest an example of a random error in obtaining any of the measurement.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [1]

(ii) Hence, suggest one way to reduce this random error.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [1]

(iii) Calculate the value of *B* with its associated uncertainty.

B = ……………………………… ± ……………………………… [3]

(iv) State and explain which measurement gives rise to the greatest uncertainty in the value for *B*.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

2 A golf ball is hit from point A on the ground and moves through the air to point B. The path of the ball is illustrated in Fig. 2.1.

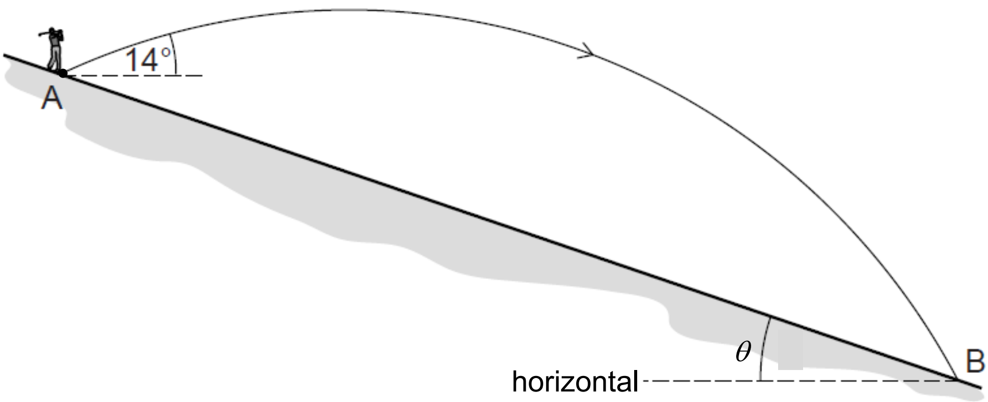


Fig. 2.1 (not to scale)

The ground slopes downhill with a constant gradient. The ball has an initial velocity of 63 m s^{-1} at an angle of 14° to the horizontal. The ball hits the ground at B after 4.9 s.

(a) Ignoring air resistance, calculate

(i) the horizontal and vertical components of the ball's velocity at A,

horizontal component of velocity at A = ... m s^{-1}

vertical component of velocity at A = ... m s^{-1} [1]

(ii) the horizontal displacement from A to B,

horizontal displacement = ... m [1]

(iii) the vertical displacement from A to B,

vertical displacement = ... m [2]

(iv) the angle of the slope to the horizontal, θ.

angle θ = ... ° [2]

(v) Describe the difference between the displacement of the ball and the distance it travels from A to B.

....

....

....

.... [2]

(b) In real situation, air resistance provides a force on the ball in the opposite direction to its motion.
On Fig 2.1, sketch a likely path of the ball hit from A when air resistance is taken into account. [2]

3 Two blocks, **A** and **B**, of masses 0.30 kg and 0.50 kg respectively, are connected by a string that passes over the pulley as shown in Fig. 3.1.

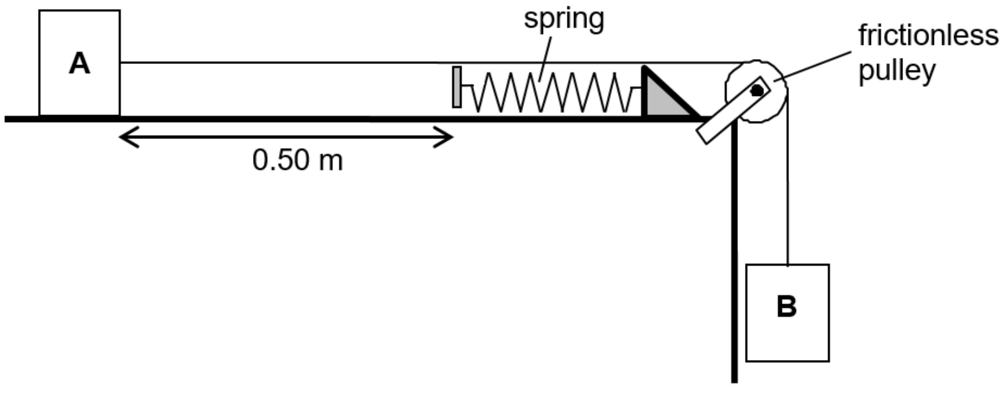


Fig. 3.1

The system is released from rest. Block **A** moves 0.50 m along the table-top and strikes a spring that is firmly attached to the table-top. The spring has a force constant of 360 N m^{-1}.

The table-top and pulley are frictionless and the string is inelastic.

(a) State *Newton's second law of motion*.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………….. [2]

(b) On Fig. 3.1 above, draw and label all the forces acting on blocks **A** and **B**. [2]

(c) Show that the magnitude of the acceleration of block **A** is 6.13 m s^{-2} before striking the spring.

[2]

(d) Calculate the tension in the string before block **A** strikes the spring.

tension = ………………………………….. N [1]

(e) Calculate the velocity of block **B** just before block **A** strikes the spring.

velocity = ………………………………….. m s^{-1} [2]

(f) Calculate the time taken for block **A** to reach the spring.

time = ………………………………… s [2]

(g) When block **A** strikes the spring, the spring will exert a force on block **A**. Determine the compression of the spring when the resultant force on block **A** is 0 N.

compression = ………………………………… m [2]

(h) Determine the maximum compression of the spring after block **A** strikes the spring.

maximum compression = ………………………………… m [3]

4 **(a)** A rectangular iceberg floats in seawater of density 1030 kg m^{-3}, as illustrated in Fig. 4.1.

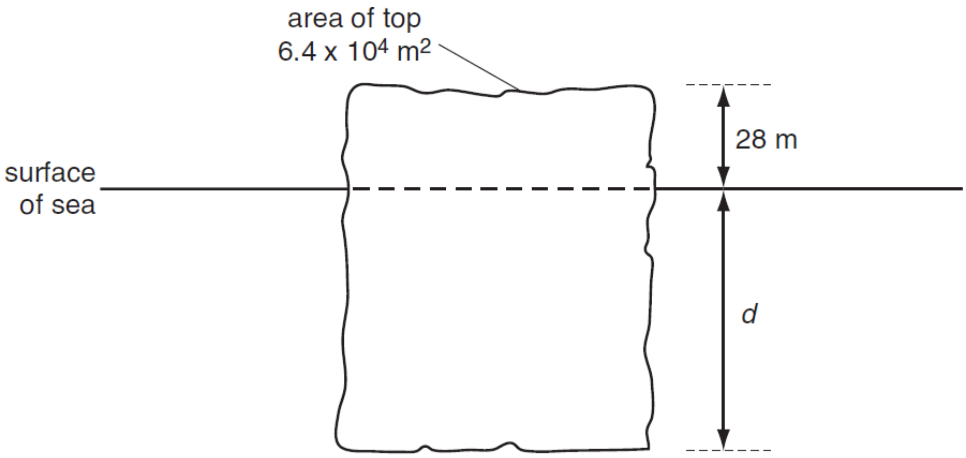


Fig. 4.1 (side view)

The iceberg floats with its top 28 m above the surface of the sea. The top surface of the iceberg has an area 6.4 ×10^4 m^2. The density of ice is 920 kg m^{-3}.

(i) The bottom of the iceberg is at a depth *d*, measured in metres. Give expressions, in terms of *d*, for

1. the mass of the iceberg,

....

....

.... [2]

2. the mass of seawater displaced by the iceberg.

....

.... [1]

(ii) Determine the depth *d*.

d = ... m [2]

(b) Two parallel strings S_1 and S_2 are attached to a disc of diameter 12 cm, as shown in Fig. 4.2.

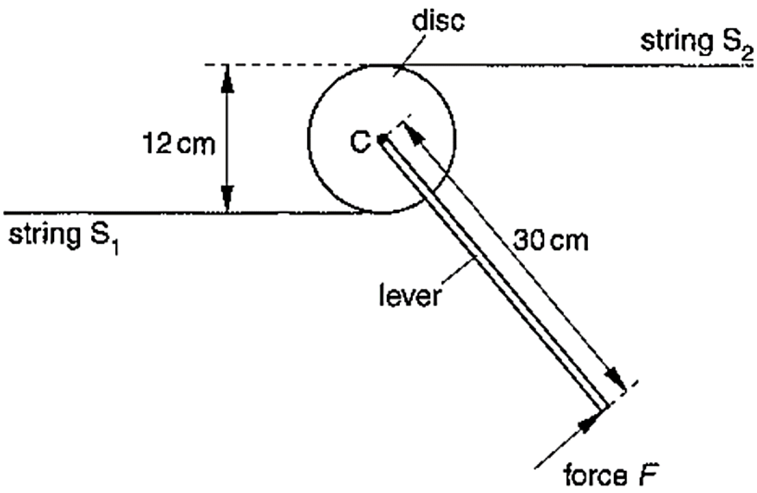


Fig. 4.2

The disc is free to rotate about an axis normal to the plane of the page. The axis passes through the centre C of the disc.

A lever of length 30 cm is attached to the disc. When a force F is applied at right angles to the lever at its end, equal forces are produced in S_1 and S_2. The disc remains in equilibrium.

(i) On Fig. 4.2, show the direction of the force in each string that acts on the disc. [1]

(ii) For a force F of magnitude 150 N, determine

1. the moment of force F about the centre of the disc,

moment = ... N m [1]

2. the torque of the couple produced by the forces in the strings,

torque = ... N m [1]

3. the force in S_1.

force = ... N [2]

5 A roller coaster, released from rest at a height H, is just able to complete the loop of radius r, as shown in Fig. 5.1.

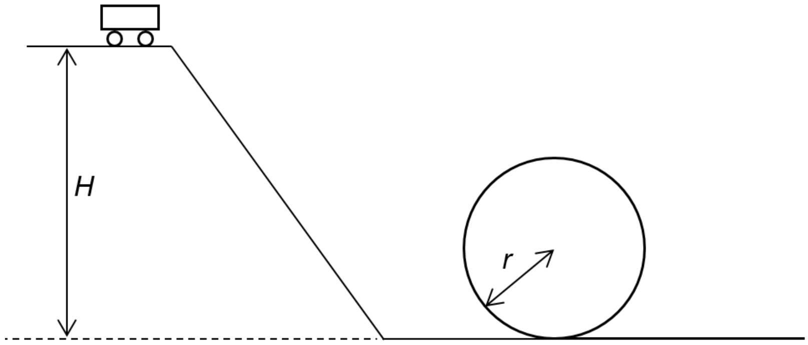


Fig. 5.1

(a) Using energy consideration, derive an expression for the velocity, v, of the roller coaster at the top of the loop, in term of g, H and r.

v = ... [2]

(b) Hence, show that $H = \frac{5}{2}r$. [2]

(c) State one assumption made in your answer in **(b)**. [1]

....

....

6 **(a)** A gravitational field may be represented by lines of gravitational force.

(i) State what is meant by a *line of gravitational force*.

....

.... [1]

(ii) By reference to lines of gravitational force near to the surface of the Earth, explain why the gravitational field strength *g* close to the Earth's surface is approximately constant.

....

....

.... [2]

(b) **(i)** Define *gravitational potential*.

....

.... [1]

(ii) Explain why values of gravitational potential near to an isolated mass are all negative.

....

....

.... [2]

(c) The gravitational potential at a point X above the surface of the planet is -5.3×10^{7} J kg^{-1}.
The gravitational potential at a point Y above the surface of the planet is -6.8×10^{7} J kg^{-1}.

(i) State, with a reason, whether point X or Y is nearer to the planet.

....

.... [1]

(ii) A rock falls radially from rest towards the planet from one point to the other.
Calculate the final speed of the rock.

speed = ... m s^{-1} [2]

END OF PAPER