Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Promotional Examination
Year 5

H2 PHYSICS 9749

Multiple Choice and Structured Questions
Additional Materials:
Multiple Choice Answer Sheet

1 October 2019
2 hours 40 minutes

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

You are advised not to spend more than 40 minutes on Section A.
There are **twenty** 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

You are advised not to spend more than 2 hours on 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	**20**
Section B	
1	**10**
2	**10**
3	**10**
4	**9**
5	**10**
6	**11**
7	**20**
s.f.	**-1**
Total	**100**

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	=	ρgh
gravitational potential,	ϕ	=	$-Gm/r$
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	=	$v_0 \cos \omega t$
		=	$\pm\omega\sqrt{x_o^2 - x^2}$
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	=	$\frac{Q}{4\pi\varepsilon_o r}$
alternating current / voltage,	x	=	$x_0 \sin \omega t$
magnetic flux density due to a long straight wire,	B	=	$\frac{\mu_0 I}{2\pi d}$
magnetic flux denxity 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.

1 The force F experienced by a charge q moving with speed v at an angle θ to a magnetic field of flux density B is given by $F = Bqv \sin \theta$.

What is the base unit for B?

A N C^{-1} m^{-1} s rad^{-1}

B kg s^{-2} A^{-1}

C kg A^{-1} rad^{-1}

D kg A^{-1}

2 The power P dissipated by a resistor of resistance R is given by $P = \frac{V^2}{R}$ where V is the potential difference across the resistor.

Experimental results give the following:

V = (6.52 ± 0.08) V
R = (18.3 ± 0.4) Ω

Calculate the power dissipated with its uncertainty.

A (2.3 ± 0.1) W

B (2.32 ± 0.05) W

C (2.32 ± 0.08) W

D (2.323 ± 0.046) W

3 A stone is thrown with a velocity of 26 m s^{-1} at an angle of 30° above the horizontal.

What is the magnitude of the change in velocity from its starting point to the highest point along its path?

A 3.5 m s^{-1} **B** 13 m s^{-1} **C** 22 m s^{-1} **D** 26 m s^{-1}

4 An object is released from an open door of an aircraft in level flight.

It takes three seconds for the object to reach terminal velocity.

Which statement about the motion of the object is correct?

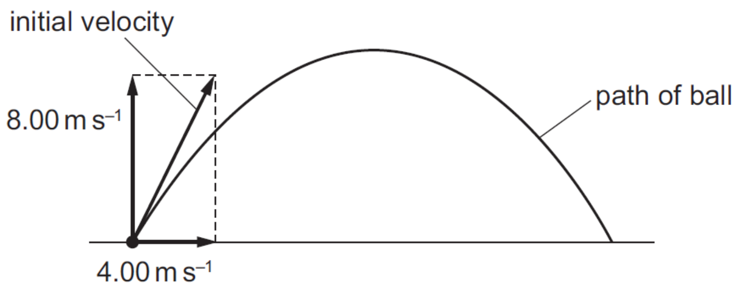
A The horizontal component of its velocity is constant.

B The horizontal component of its acceleration is zero.

C The vertical component of its velocity decreases for three seconds.

D The vertical component of its acceleration is zero after three seconds.

5 An astronaut throws a ball near the surface of the Moon, where there is no air resistance. The ball's initial velocity has a vertical component of 8.00 m s^{-1} and a horizontal component of 4.00 m s^{-1} as shown.



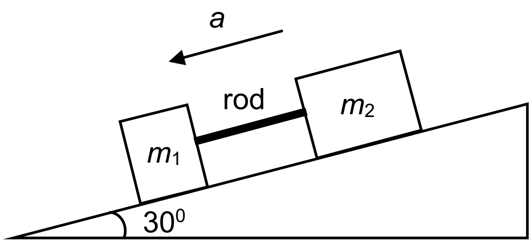
The acceleration of free fall near the surface of the Moon is 1.62 m s^{-2}.

What will be the speed of the ball 9.00 s after being thrown?

A 7.7 m s^{-1} **B** 22.9 m s^{-1} **C** 80.4 m s^{-1} **D** 96.4 m s^{-1}

6 Two objects of masses m_1 and m_2 are connected by a light rod as shown. The objects are moving with acceleration a, down a smooth slope that is inclined at an angle 30^0 to the horizontal.

What is the tension in the rod?



A $0.5m_1a$

B $(m_1 + m_2)a$

C $(m_1 - m_2)a$

D zero

7 Student A and Student B engage in a game of tug of war. Student A wins the game, and Student B falls forward.

Which of the following statements is correct?

A The force exerted by Student A on Student B is larger than that exerted by Student B on Student A.

B The frictional forces exerted by the ground on both students are the same.

C The force exerted by Student A on Student B is larger than the frictional force exerted by the ground on Student B.

D All of the above.

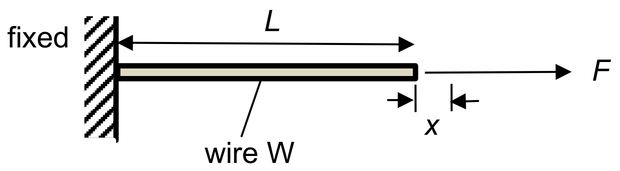
8 The three forces acting on a hot-air balloon that is moving vertically are its weight, the air resistance and the upthrust.

The hot-air balloon descends vertically at constant speed. The air resistance exerted on the balloon is F.

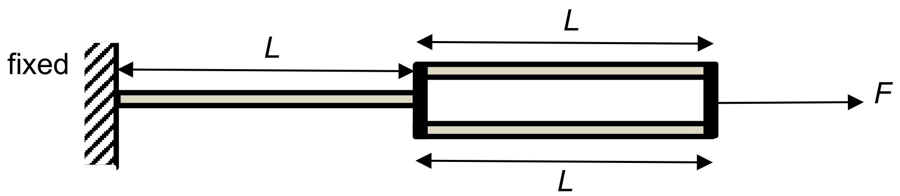
What weight of material must be released from the balloon so that it ascends vertically at the same constant speed?

A F **B** $2F$ **C** $3F$ **D** $4F$

9 A wire W, initially of length L, is fixed at one end and pulled by a force F at the other end. The wire extends by x.



Three wires, all identical to wire W, are connected as shown to form a composite wire.



The composite wire is fixed at one end and pulled by the same force F at its other end.

What is the total extension of the composite wire?

A $\frac{5}{6}x$ **B** $\frac{4}{3}x$ **C** $\frac{3}{2}x$ **D** $2x$

10 A car of mass 1.5×10^3 kg travels along a horizontal road at a speed of 20 m s^{-1}. It then accelerates at 0.30 m s^{-2}. At the time it begins to accelerate, the total resistive force acting on the car is 360 N.

What total output power is developed by the car as it begins the acceleration?

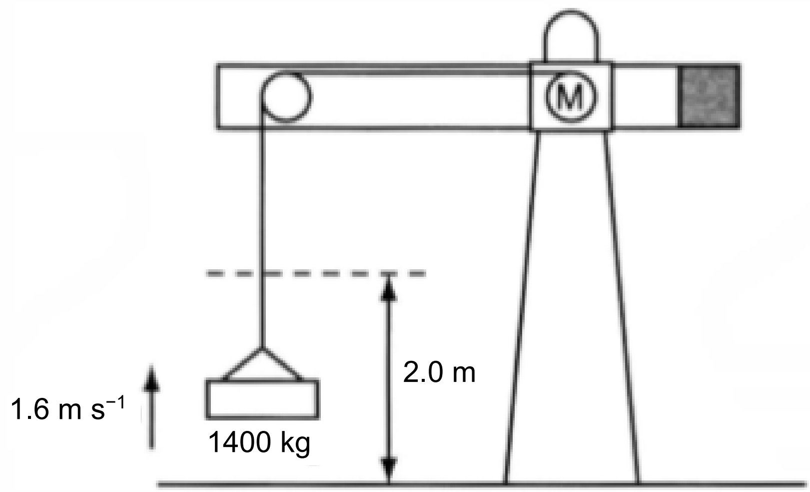
A 1.8 kW **B** 7.2 kW **C** 9.0 kW **D** 16.2 kW

11 A stone is thrown at an initial velocity *u* at an angle of 30° above the horizontal. Its initial kinetic energy is *K*.

What is the kinetic energy, in term of *K*, of the stone at the highest point of the motion?

A 0 *K* **B** 0.50 *K* **C** 0.75 *K* **D** 0.87 *K*

12 The motor M in a crane is used to lift a total mass of 1400 kg through a height of 2.0 m at a constant speed of 1.6 m s^{-1}. The motor is 20% efficient.



What is the minimum input power to motor M?

A 11 kW **B** 22 kW **C** 110 kW **D** 140 kW

13 A radar tower 150 m tall is built at the equator on top of a hill 2850 m high above mean sea level.

As a result of the Earth's rotation, what is the difference in speed between a man at the top of the tower and someone at mean sea level?

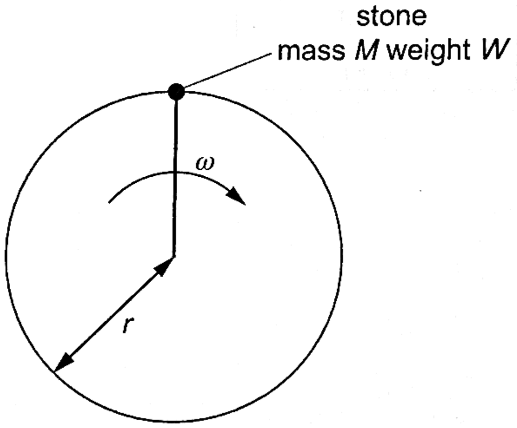
A 0 m s^{-1}

B 0.011 m s^{-1}

C 0.22 m s^{-1}

D 790 m s^{-1}

14 A stone of mass M and weight W is attached to a string and is rotating in a vertical circle of radius r. The stone has an angular velocity ω when it is vertically above the centre of the circle.



What is the tension in the string when the stone is vertically above the centre of the circle?

A $Mr\omega^2 - W$ **B** $Mr\omega^2$ **C** $W - Mr\omega^2$ **D** $W + Mr\omega^2$

15 Which of the following is a property of a uniform gravitational field?

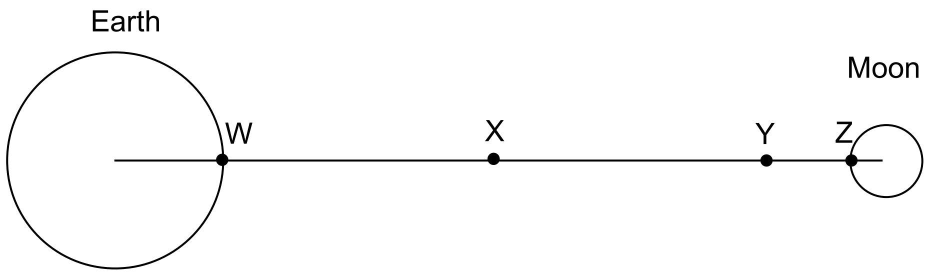
A Its magnitude is the same in all directions.

B No work is done if an object moved into it.

C The potential has the same value at all points within it.

D Its field strength is the same at all points within it.

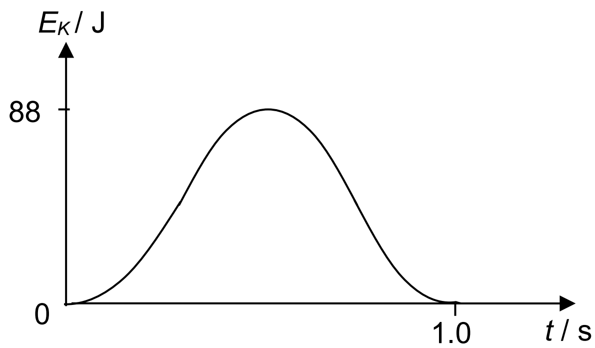
16 The figure below shows points W, X, Y and Z on a line joining the centre of the Earth to the centre of the Moon. W and Z are on the surfaces of the Earth and Moon respectively. X is the mid-point between the Earth and the Moon. Y is a point where a mass placed there will not experience any resultant force.



Which two points have the greatest difference in gravitational potential?

A W and X **B** W and Y **C** W and Z **D** Y and Z

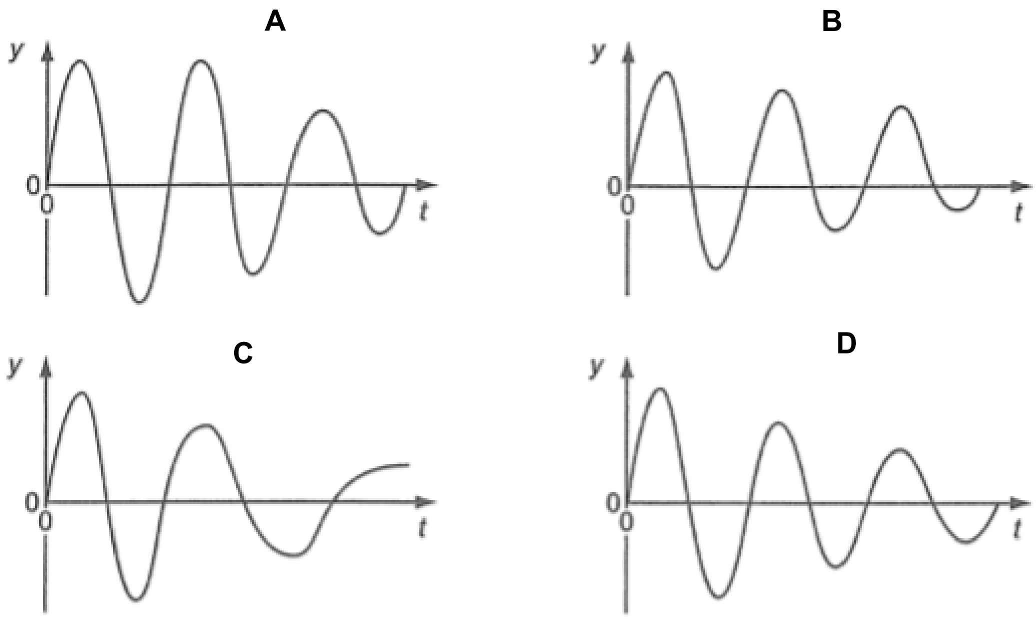
17 A particle of mass 3.0 kg undergoes simple harmonic motion. The graph below shows the variation with time t of its kinetic energy E_K.



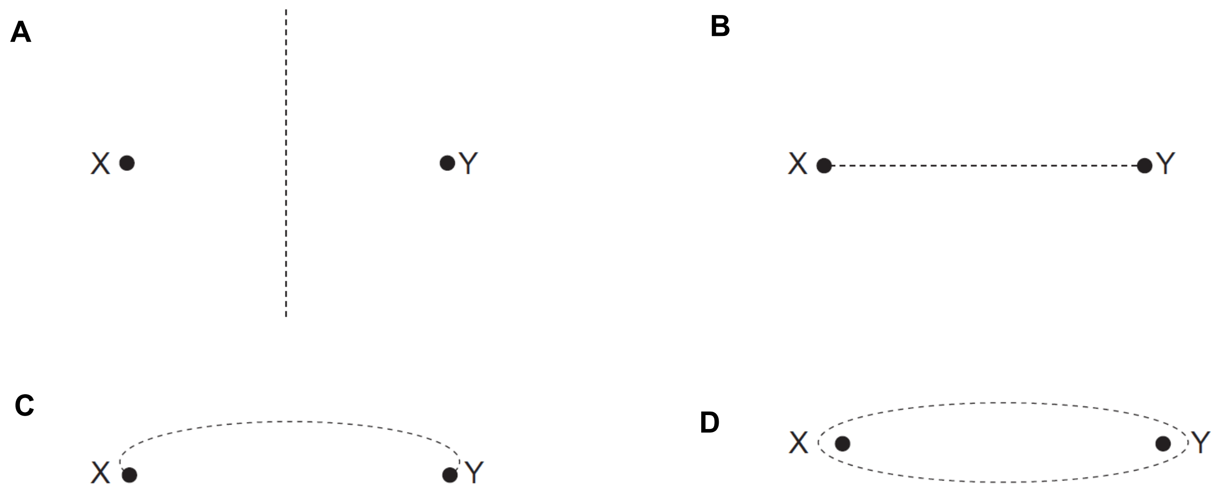
What is the maximum acceleration of the particle?

A 12 m s^{-2} **B** 24 m s^{-2} **C** 36 m s^{-2} **D** 48 m s^{-2}

18 Which diagram shows the variation with time t of the displacement y of an object that is undergoing lightly-damped oscillations?



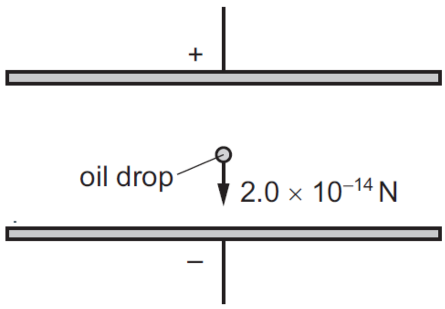
19 Which diagram shows a correct equipotential line due to two point charges X and Y of equal magnitude and opposite sign?



20 A charged oil drop is held stationary between two oppositely charged horizontal plates.

The weight of the oil drop is 2.0×10^{-14} N.

The potential difference between the plates is 400 V.



The potential difference between the plates is now increased to 600 V and the polarities of the plates reversed.

What is the magnitude of the resultant force acting on the oil drop?

A 1.0×10^{-14} N

B 2.0×10^{-14} N

C 3.0×10^{-14} N

D 5.0×10^{-14} N

Section B

Answer **all** the questions.

1 A stone is thrown vertically upwards. The variation with time t of the displacement s of the stone is shown in Fig. 1.1.

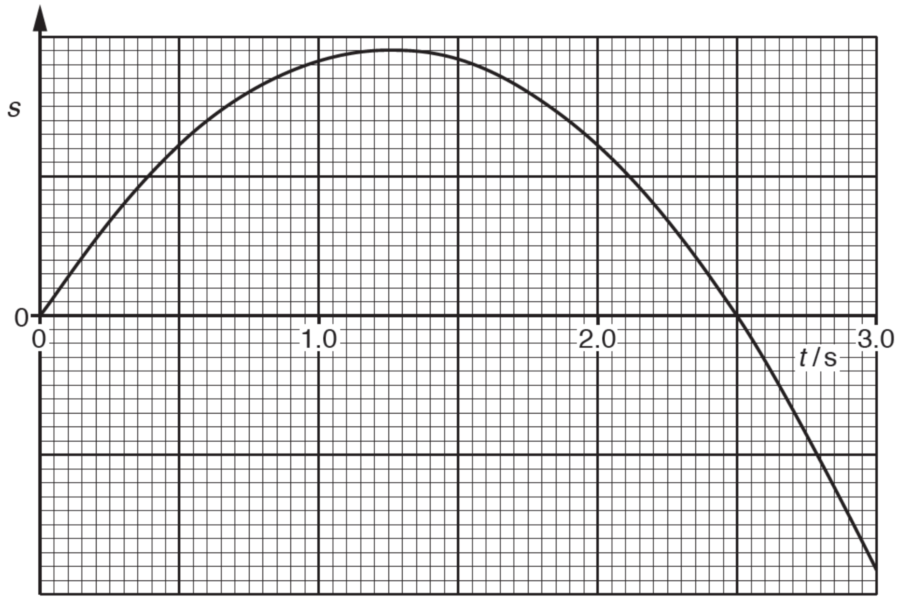


Fig. 1.1

(a) Use Fig. 1.1 to describe, without calculation, the speed of the stone from $t = 0$ to $t = 3.0$ s.

....

....

....

.... [2]

(b) Assume air resistance is negligible.

Calculate, for the stone,

(i) the speed at 3.0 s,

speed = …………………… m s^{-1} [2]

(ii) the distance travelled from t = 0 to t = 3.0 s,

distance = …………………… m [2]

(iii) the displacement from t = 0 to t = 3.0 s.

displacement = …………………… m

direction ……………………………………………… [2]

(c) Using Fig. 1.2, sketch the variation with time t of the velocity v of the stone from $t = 0$ to $t = 3.0$ s. Numerical values of the velocity are not required for this sketch. [2]

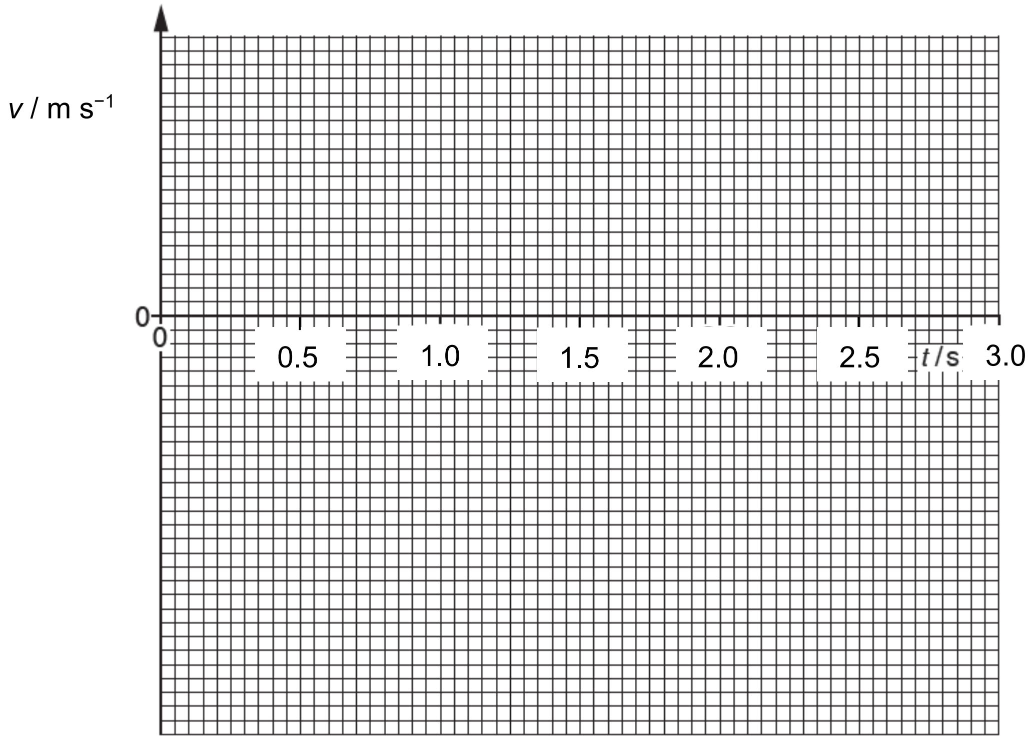


Fig. 1.2

2 A student is investigating the different possible types of collision undergone by two objects.

In the study, box A of mass 0.50 kg and box B of mass 0.30 kg move toward each other on a frictionless track as shown in Fig. 2.1. Both boxes have the same initial speed of 2.0 m s^{-1}.

Fig. 2.1

(a) State the *principle of conservation of momentum*.

....

....

.... [2]

(b) The student assumes that both boxes undergo an elastic head-on collision. After the collision, box A and box B move off with velocity V_A and V_B respectively.

Calculate V_A and V_B.

V_A = ... m s^{-1}

V_B = ... m s^{-1} [3]

(c) In another scenario, the student places sticky tape on box B such that the two boxes stick together after the collision.

(i) Determine the magnitude of the final velocity of box A and box B.

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

(ii) State and explain whether the acceleration of box A is greater, smaller than or equal to the acceleration of box B during the collision.

....

....

.... [2]

(iii) Calculate the ratio

$$\frac{\text{total kinetic energy of box A and box B after the collision}}{\text{total kinetic energy of box A and box B before the collision}}.$$

ratio = ……………….……………….. [2]

3 **(a)** A cylinder of circular cross-sectional area is made from a material of density 2.7 g cm^{-3}. The cylinder has diameter 2.4 cm and length 5.0 cm.

Show that the weight of the cylinder is 0.60 N. [2]

(b) The cylinder in **(a)** is hung from end A of a non-uniform bar AB, as shown in Fig. 3.1.

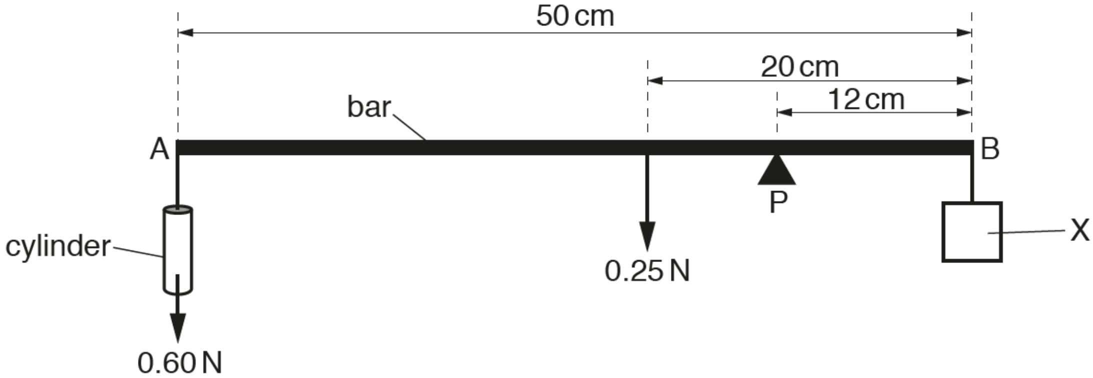


Fig. 3.1

The bar has length 50 cm and has weight 0.25 N. The centre of gravity of the bar is 20 cm from B. The bar is pivoted at P. The pivot is 12 cm from B.

An object X is hung from end B. The weight of X is adjusted until the bar is horizontal and in equilibrium.

(i) Explain what is meant by *equilibrium*.

....

.... [2]

(ii) Calculate the weight of X.

weight = …………………… N [2]

(c) The cylinder is now immersed in a liquid of density 1.26 g cm^{-3}, as illustrated in Fig. 3.2.

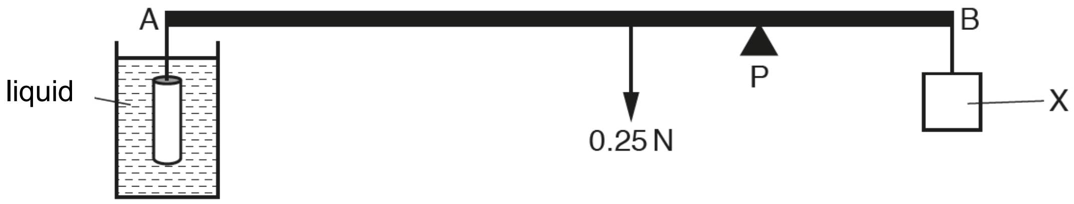


Fig. 3.2

An upthrust acts on the cylinder and the bar is not in equilibrium.

(i) Explain the origin of the upthrust.

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [1]

(ii) Explain why the weight of X must be reduced in order to obtain equilibrium for the bar.

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [1]

(iii) Calculate the new weight of X needed to achieve equilibrium for the bar.

new weight = ……………………. N [2]

4 **(a)** An object moving in a circular path of radius r experiences an acceleration a even when travelling at constant speed v.

(i) Explain how it is possible for the object to accelerate and yet at the same time have constant speed.

....

....

....

....

.... [3]

(ii) State an expression for this acceleration a in term of v and r.

.... [1]

(b) Fig. 4.1 shows the forces acting on a child who is riding backwards and forwards on a swing that follows a circular arc of radius r.

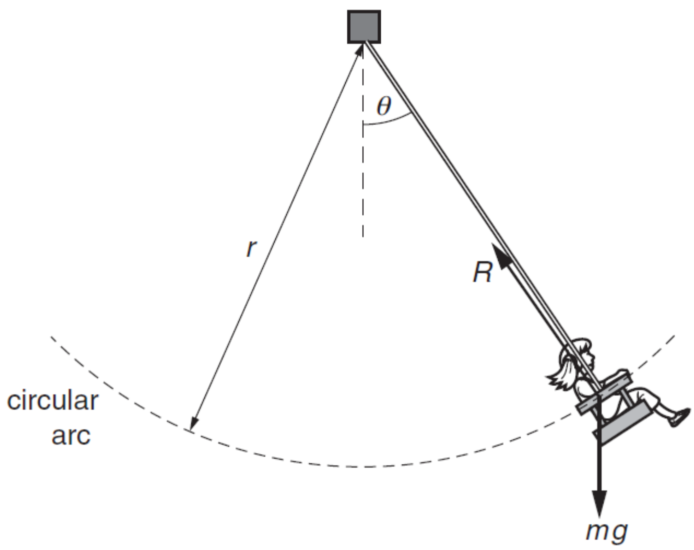


Fig. 4.1 (not to scale)

The child's weight is mg. R is the force of the seat on the child. As the instantaneous speed v of the child changes, R also varies.

As the child swings through the lowest point on the circular arc, $\theta = 0°$, her instantaneous speed is $4.7\ m\ s^{-1}$. The child weighs 200 N and the radius r is 2.8 m.

Calculate the value of R at this instant.

R = ... N [2]

(c) A car moves in a horizontal circular path of constant radius. While the car is travelling around the circle, the people in the car have the sensation that they are being thrown outwards.

Outline how Newton's first law of motion accounts for this sensation.

....

....

....

....

....

.... [3]

5 A satellite of mass m orbits the Earth of mass M and radius r_E. The radius of the orbit is R. The satellite and the Earth may be considered to be point masses with their masses concentrated at their centres. They may be assumed to be isolated in space.

(a) **(i)** State Newton's law of gravitation.

....

....

.... [1]

(ii) Derive, in terms of M and r_E, the equation relating the Earth's gravitational field strength g to the gravitational constant G. [2]

(b) The angular velocity of the satellite is equal to the angular velocity of the Earth's rotation about its own axis.

For the satellite in orbit of radius R, obtain an equation between R and r_E. [4]

(c) A Physics student made this statement: "If a geostationary satellite orbits at a larger radius, then it must have a larger orbital velocity so that it will still take 24 hours to make a revolution."

Explain whether the statement is true.

....

....

....

.... [1]

(d) It is generally possible to have a satellite orbit the Earth from east to west as well as from west to east.

Explain why it is normally preferred to launch a satellite from west to east at the equator.

....

....

....

.... [2]

6 **(a)** State what is meant by an *electric field*.

....

.... [1]

(b) An isolated solid metal sphere has radius R. The charge on the sphere is $+Q$ and the electric field strength at its surface is E.

On Fig. 6.1, draw a line to show the variation of the electric field strength with distance x from the centre of the solid sphere for values of x from $x = 0$ to $x = 3R$.

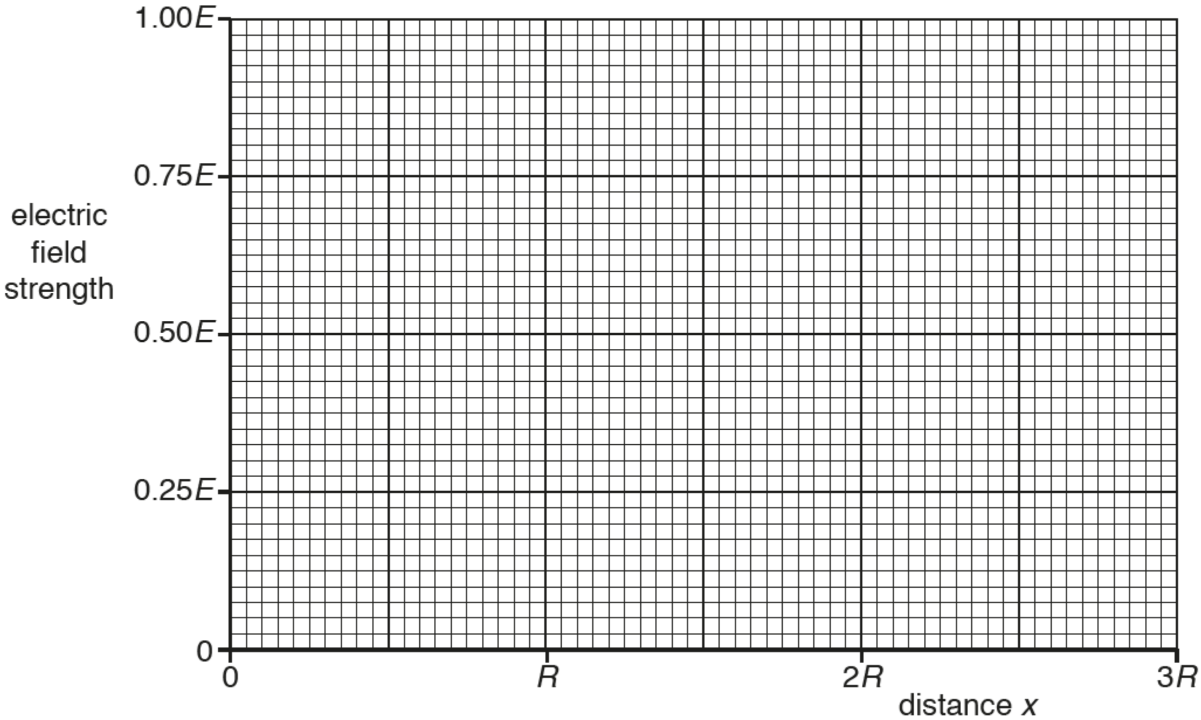


Fig. 6.1

[4]

(c) The sphere in **(b)** has radius $R = 0.26$ m.

Electrical breakdown (a spark) occurs when the electric field strength at the surface of the sphere exceeds 2.0×10^6 V m^{-1}.

Before electrical breakdown occurs, determine

(i) the maximum charge that can be stored on the sphere,

charge = ... C [3]

(ii) the electric potential at the surface of the sphere.

electric potential = ... V [3]

7 **(a)** For an object oscillating in simple harmonic motion, state the features of the graph of the variation with displacement of its acceleration.

....

....[2]

(b) Fig. 7.1 shows a mass suspended on a spring. The force constant of the spring is 0.032 N cm^{-1}. The spring is loaded with a mass of 450 g.

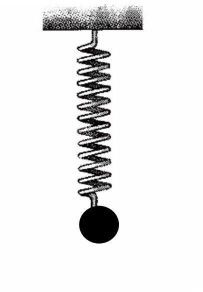


Fig. 7.1

The mass is pulled down by a distance 4.0 cm below the equilibrium position and then released at time t = 0. It undergoes simple harmonic motion.

The frequency of the oscillation is given by $f = \frac{1}{2\pi}\sqrt{\frac{k}{M}}$ where k is the spring constant and M is the mass of the load.

Calculate, for the mass,

(i) the time taken for one complete oscillation.

time = ... s [3]

(ii) its speed when it is 1.0 cm above the lowest point of oscillation.

speed = ... m s^{-1} [3]

(iii) On Fig. 7.2, sketch the variation with time t, of displacement x, velocity v and the acceleration a, for one complete oscillation. Take upward direction as positive. You are required to indicate numerical values on each axis.

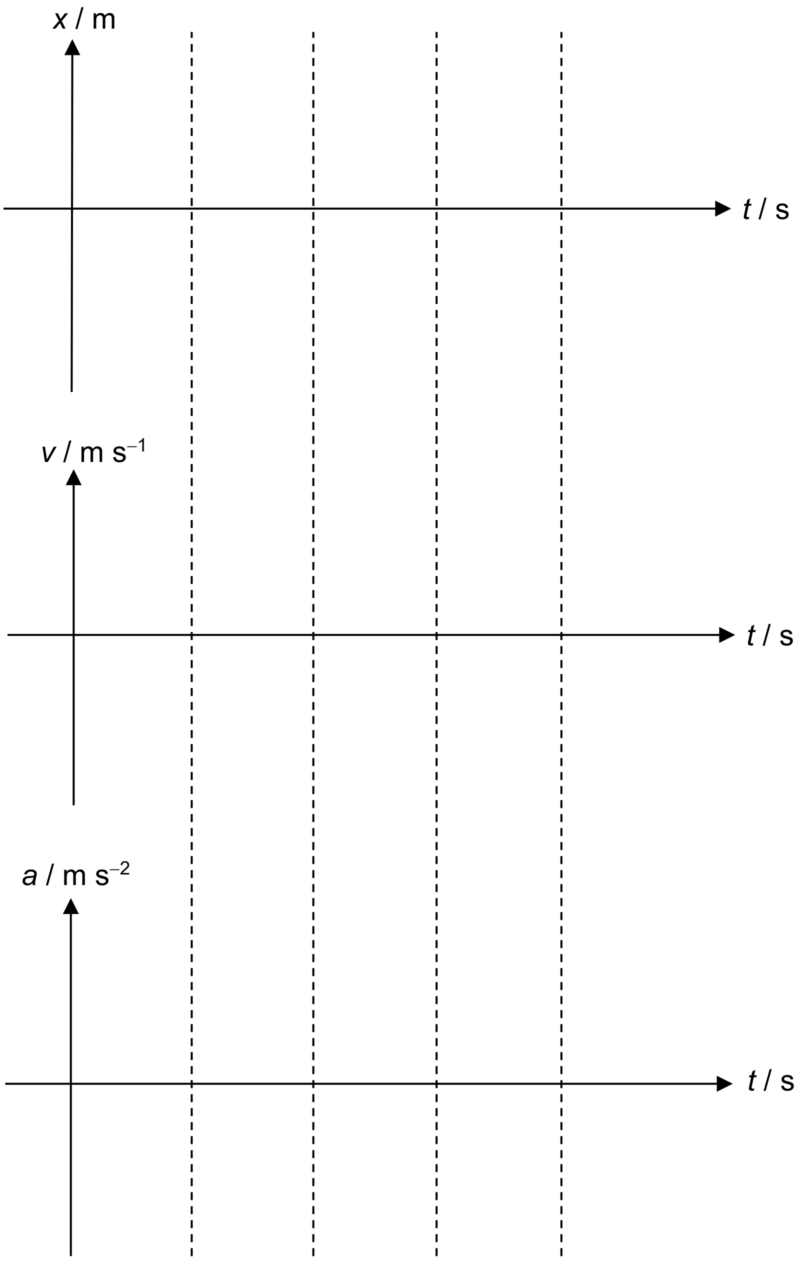


Fig. 7.2

[7]

(c) Indiana Jones is outside the Temple of Doom. His pathway is blocked by a huge blade that moves up and down with simple harmonic motion as shown in Fig. 7.3. The top edge of the blade moves all the way up to the roof, which is at a height of 2.20 m above the ground, and the bottom edge of the blade touches the ground every 4.0 s as shown in the figure. The blade has a vertical width of 0.80 m.

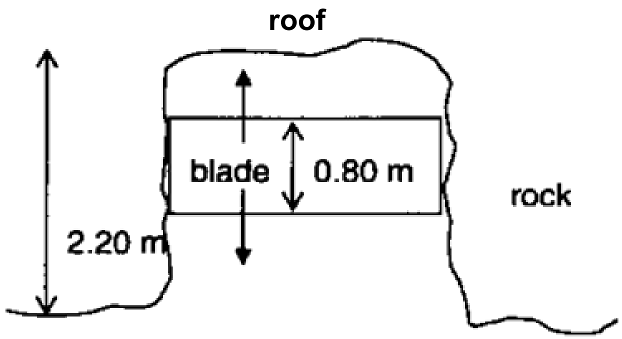


Fig. 7.3

(i) Determine the amplitude of the oscillation.

amplitude = …………………….. m [2]

(ii) The only way Indiana can enter the Temple of Doom is to roll under the blade. Indiana needs a space that is at least 0.55 m high to do so.

Find the maximum duration in one cycle that Indiana has to roll under the blade.

duration = …………………….. s [3]

END OF PAPER