Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Mid Year Examination
Year 5

H2 PHYSICS

9749

Multiple Choice and Structured Questions

1 July 2022

Additional Materials: Multiple Choice Answer Sheet

2 hours

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.

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

Section B
Answer **all** questions.

The number of marks is given in brackets [ ] at the end of each question or part question.

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

For Examiner's Use	
Section A	
MCQ	15
Section B	
1	10
2	9
3	9
4	11
5	11
6	10
s.f.	-1
Total	75

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	=	$\frac{1}{3}\frac{Nm}{V} < c^2 >$
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 power P radiated from a spherical black body can be described using the Stefan-Boltzmann law given by:

$$P = A\sigma T^4$$

where A is the surface area of the spherical black body, σ is the Stefan-Boltzmann constant, and T is the thermodynamic temperature on the surface of the black body.

Which of the following is the unit of σ in SI base units?

A W m^{-2} K^{-4} **B** W s m^{-2} K^{-4} **C** kg s^{-3} K^{-4} **D** kg s^{-2} K^{-4}

2 A car initially travels towards the North at a velocity of 12 m s^{-1}. After some time, it travels towards the West at a velocity of 5.0 m s^{-1}.

What is its change in velocity?

A 7.0 m s^{-1} at a direction of 23° East of North.

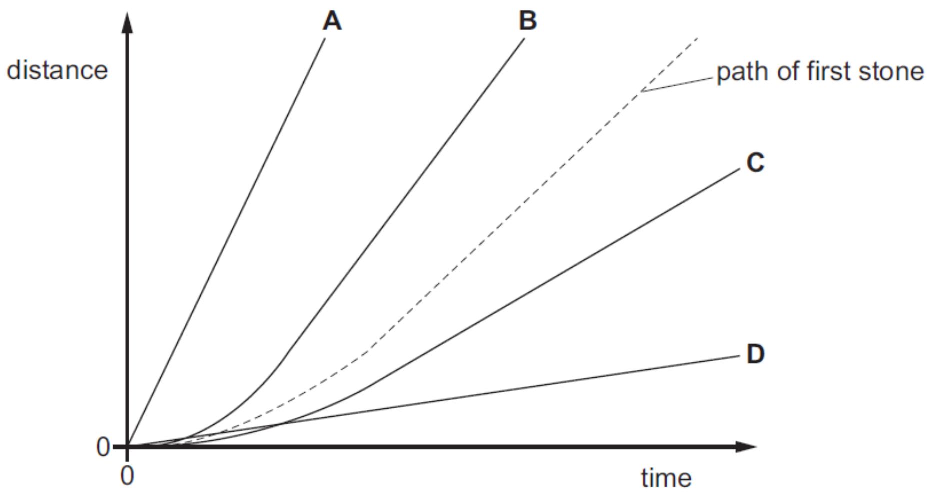
B 7.0 m s^{-1} at a direction of 23° west of North.

C 13 m s^{-1} at a direction of 23° East of South.

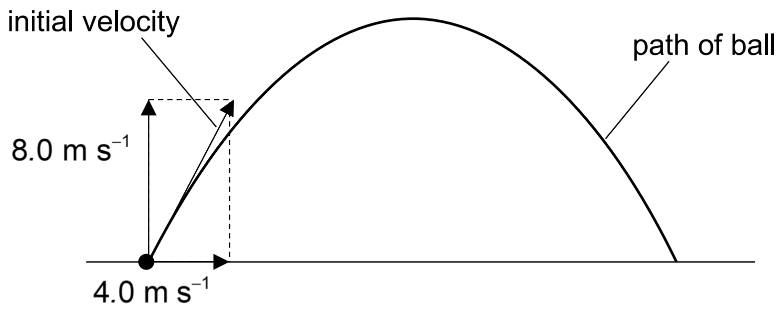
D 13 m s^{-1} at a direction of 23° West of South.

3 A stone is dropped from a tall building. Air resistance is not negligible. The variation of distance travelled by the stone with time is shown by the dashed line. A second stone with the same dimensions but a smaller mass is dropped from the same building.

Which line represents the motion of the second stone?



4 An astronaut on the Moon, where there is no air resistance, throws a ball. The ball's initial velocity has a vertical component of 8.0 m s^{-1} and a horizontal component of 4.0 m s^{-1}, as shown.

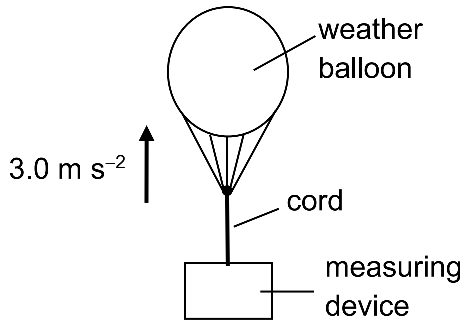


The acceleration of free fall on the Moon is 1.62 m s^{-2}.

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

A 6.6 m s^{-1} **B** 7.7 m s^{-1} **C** 10.6 m s^{-1} **D** 14.6 m s^{-1}

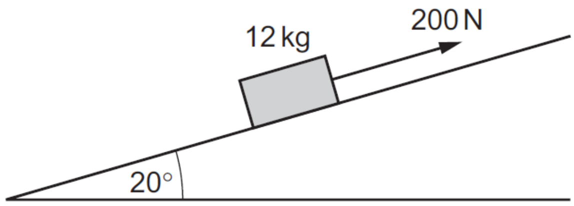
5 A weather balloon of mass 8.0 kg is attached to a measuring device of mass 5.0 kg by an inextensible cord of negligible mass as shown below.



If the system is accelerating vertically upwards at 3.0 m s^{-2}, what is the tension in the cord?

A 15 N **B** 39 N **C** 64 N **D** 167 N

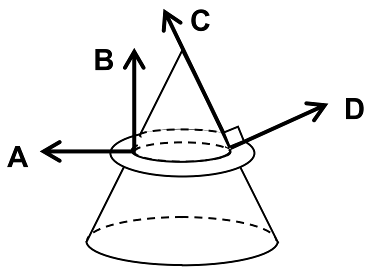
6 An object of mass 12 kg is pulled up a smooth inclined plane by a force of 200 N parallel to the plane, as shown in the diagram. The inclined plane is at an angle of 20° to the horizontal.



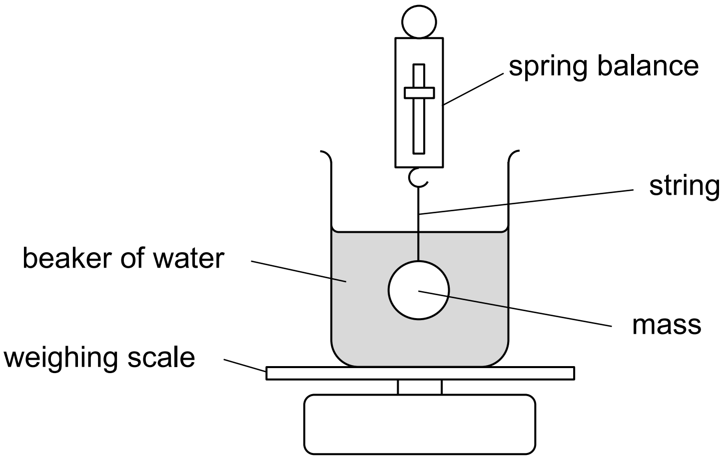
What is the resultant force on the object?

A 110 N **B** 160 N **C** 196 N **D** 200 N

7 The diagram below shows a flat ring that is resting horizontally on the exterior surface of a cone. Assuming that friction is negligible, which of the arrows below shows a correct direction of the normal reaction acting on a point of the flat ring?



8 A beaker of water of total weight W is placed on a weighing scale. A mass of weight M is then lowered into the beaker of water, while suspended from a spring balance using a light inextensible string. The reading on the spring balance is T when the mass is fully submerged in the beaker of water as shown. No water is spilled from the beaker in the process.



What is the reading on the weighing scale when the mass is fully submerged in the beaker of water?

A $W + M$ **B** $W + T$ **C** $W + M + T$ **D** $W + M - T$

9 Blocks A and B, each of mass 2.0 and 1.0 kg respectively are connected by a massless spring and arranged on a frictionless table as shown in Fig. 9 (a). A constant force F is applied at one side of block A.

After that, they are rearranged as shown in Fig. 9 (b). The same constant force F is applied at one side of block B.

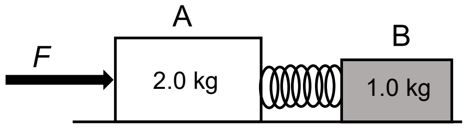


Fig. 9 (a)

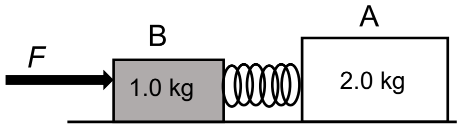
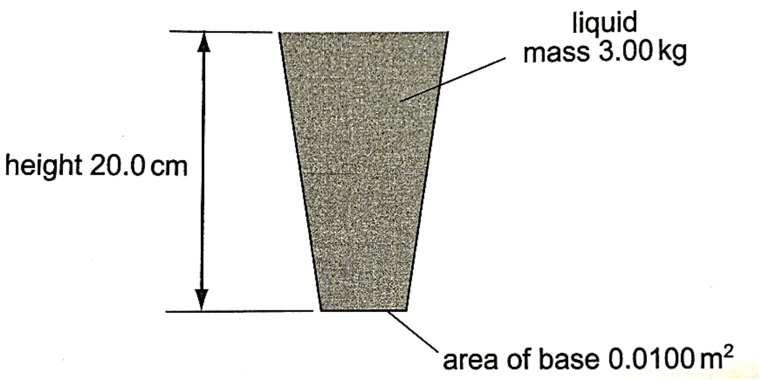


Fig. 9 (b)

What is the ratio of the compression of the spring in Fig. 9 (a) to that in Fig. 9 (b)?

A 1 : 2 **B** 2 : 1 **C** 1 : 3 **D** 1 : 1

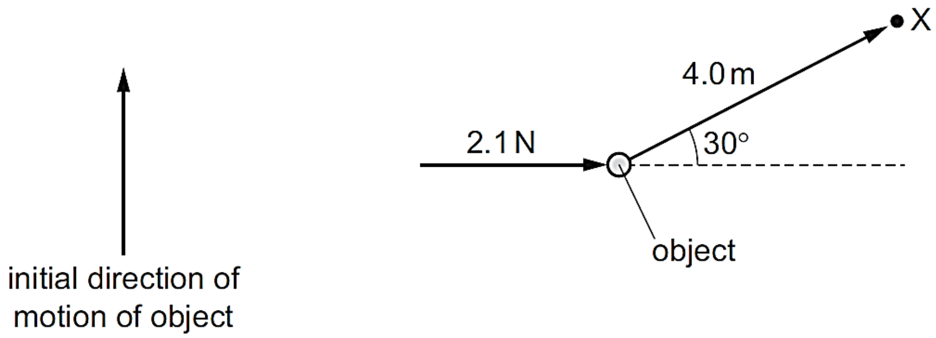
10 The diagram shows a jar, with the dimensions shown, containing a liquid of mass 3.00 kg and density 600 kg m^{-3}. The liquid exerts a pressure on the base of the jar.



What is the pressure exerted by the liquid on the base of the jar?

A 1.18×10^3 Pa **B** 2.94×10^3 Pa **C** 1.18×10^5 Pa **D** 2.94×10^6 Pa

11 An object slides with constant velocity across a horizontal sheet of ice. Friction is negligible. A constant horizontal force of 2.1 N is then applied to the object as shown.

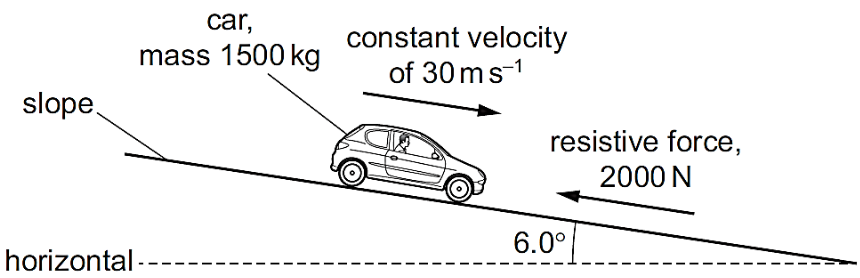


A short time after applying the force, the object reaches point X at a displacement of 4.0 m from its position when the force was first applied.

What is the work done by the force on the object as it travels to point X?

A 4.2 J **B** 4.8 J **C** 7.3 J **D** 8.4 J

12 A car of mass 1500 kg travels at a constant velocity of 30 m s^{-1} down a slope. The slope is at an angle of 6.0° to the horizontal, as shown.



The magnitude of the total resistive force acting on the car is 2000 N.

What is the power output of the car's engine?

A 14 kW **B** 60 kW **C** 110 kW **D** 380 kW

13 The reading of a speedometer fitted to the front wheel of a bicycle is directly proportional to the angular velocity of the wheel. A certain speedometer is correctly calibrated for use with a wheel of diameter 60 cm but, by mistake, is fitted to a wheel of diameter 50 cm.

The percentage error in the readings of indicated linear speed would be

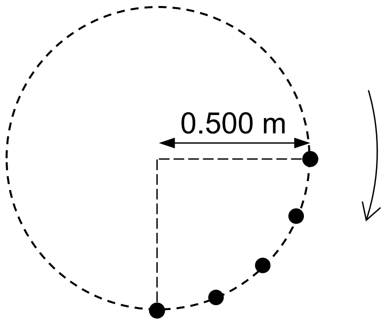
A less than the actual linear speed by 17%.

B greater than the actual linear speed by 17%.

C less than the actual linear speed by 20%.

D greater than the actual linear speed by 20%.

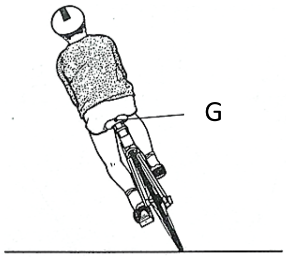
14 An object is travelling in a circle of radius 0.500 m as shown in the figure below. A student takes a photograph of the object using a stroboscope. The dots represent the position of the object at every 0.250 s interval.



What is the acceleration of the object towards the centre of the circle?

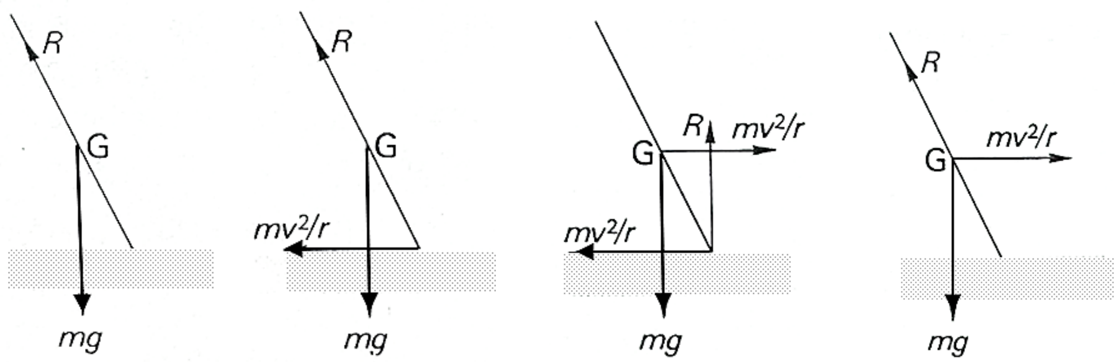
A 0.79 m s^{-2} **B** 1.23 m s^{-2} **C** 1.58 m s^{-2} **D** 12.5 m s^{-2}

15 The diagram represents a cyclist making a left turn on a rough road surface at constant speed *v*, as viewed from behind. The total mass of the bicycle and rider is *m* and their combined centre of gravity is at G.



If *R* is the resultant force of the normal reaction and the frictional force, which vector diagram represents the directions of the forces acting on the bicycle and its rider?

A **B** **C** **D**



END OF SECTION A

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Section B

Answer **all** the questions.

1 A smooth pebble, made from uniform rock, has the shape of an elongated sphere as shown in Fig. 1.1.

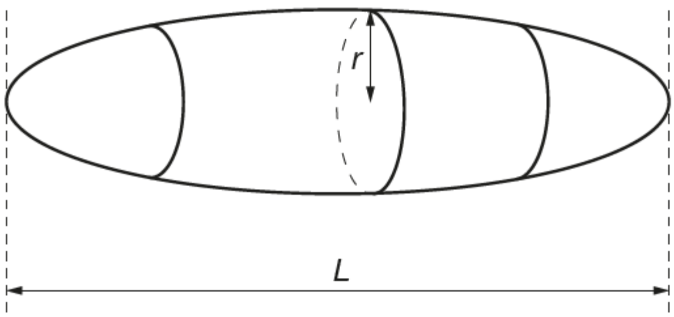

Fig. 1.1

The length of the pebble is L. The cross-section of the pebble, in the plane perpendicular to L, is circular with a maximum radius r.

A student investigating the density of the rock makes measurements to determine the values of L, r and the mass M of the pebble as follows:

$$L = (0.1242 \pm 0.0001)\ \text{m}$$

$$r = (0.0420 \pm 0.0004)\ \text{m}$$

$$M = (1.072 \pm 0.001)\ \text{kg}.$$

(a) Define *density*.

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

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

(b) State the name of a measuring instrument suitable for making this measurement of L.

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

(c) Determine the percentage uncertainty in the measurement of r.

percentage uncertainty in r = …………………………… % [1]

(d) The density ρ of the rock from which the pebble is composed, is given by

$$\rho = \frac{Mr^n}{kL}$$

where n is an integer and k is a dimensionless constant that is equal to 2.094.

(i) Show that n is equal to -2.

[2]

(ii) Calculate the percentage uncertainty in ρ.

percentage uncertainty in ρ = …………………………….. % [2]

(iii) Hence, determine ρ with its absolute uncertainty.

ρ = (……………. ± ……….…….) kg m^{-3} [3]

[Total: 10]

2 **(a)** Explain why it is technically incorrect to define speed as “distance travelled per second”.

Include in your answer the correct definition of speed.

………………………………………………………………………………………………….…………

………………………………………………………………………………………………….…………

………………………………………………………………………………………………….…………

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

(b) A tennis ball is thrown vertically downwards and bounces on the ground. The ball leaves the hand with an initial speed of 1.5 m s^{-1} and at a height of 0.65 m above the ground. The ball rebounds and is caught when it is travelling upwards with a speed of 1.0 m s^{-1}.

Assume that air resistance is negligible.

(i) Calculate the speed of the ball just before it strikes the ground.

speed = ……………………………. m s^{-1} [2]

(ii) The ball is thrown at $t = 0$. It hits the ground at t_1 and is caught at time t_2.

The initial velocity **X** and final velocity **Y** are marked on Fig 2.1.

On Fig 2.1, sketch the velocity-time graph for the vertical motion of the tennis ball from the time it leaves the hand to when it is caught. Assume that the contact time between the ball and the ground is negligible. [3]

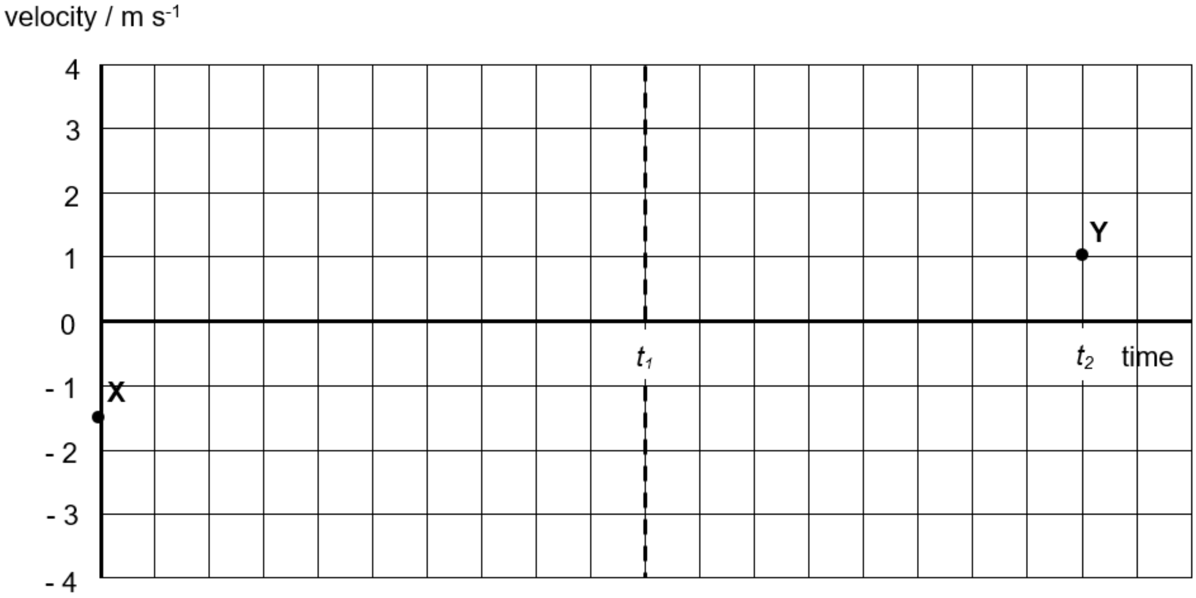

Fig. 2.1

(iii) Explain if the bounce is elastic.

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

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

[Total: 9]

3 **(a)** Two trucks collide head-on with equal speeds v on a highway covered with ice, as shown in Fig. 3.1. The mass of the big truck is 3 times that of the small truck.

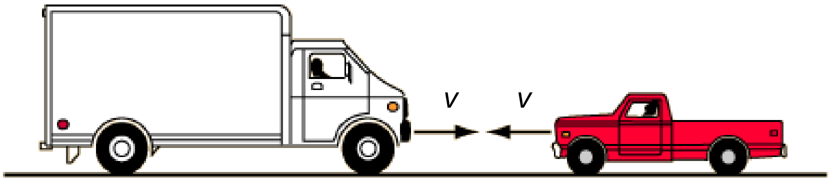

Fig. 3.1

The force exerted by the big truck on the small truck varies with time as shown in Fig. 3.2.

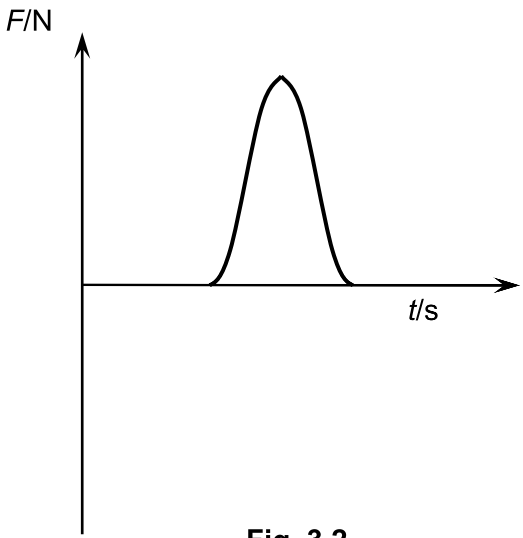

Fig. 3.2

(i) On Fig. 3.2, sketch a graph of the force exerted by the small truck on the big truck. [1]

(ii) Explain how your answer in **(a)(i)** is consistent with the principle of conservation of momentum.

....

....

....

....

....

.... [3]

(b) An investigation of the collision found that v was 70 km h^{-1}. After the collision, the big truck moved briefly in its original direction at 0.60v.

(i) Determine the magnitude of the velocity of the small truck just after the collision.

velocity of the small truck just after the collision = ... m s^{-1} [2]

(ii) The mass of the big truck is 15000 kg. The duration of the impact was 1.2 s. Determine the average force exerted by the big truck on the small truck.

average force = ... N [2]

(c) The front of both trucks crumpled significantly during the collision. The drivers of both trucks were not injured critically. Use your understanding of impulse to explain how this crumpling might contribute to the survival of the drivers, besides seat belts and air bags.

....

.... [1]

[Total: 9]

4 **(a)** Define *moment* of a force about a point.

....

....

.... [2]

(b) Fig. 4.1 shows a crane being used to lift and lower a load of mass 300 kg. The load at point B is attached to point A of the jib using a hoist rope.

Another supporting cable attached at point C supports the far end of the jib at point A. The supporting cable makes an angle of 25° with the jib at point A. The nearer end of the jib is connected to the cab at point D.

The mass of the jib is 2400 kg and the mass of the cab is 16000 kg. Their centres of mass are at their mid-points E and F respectively. The masses of the hook at point B, the supporting cable and the hoist rope are negligible.

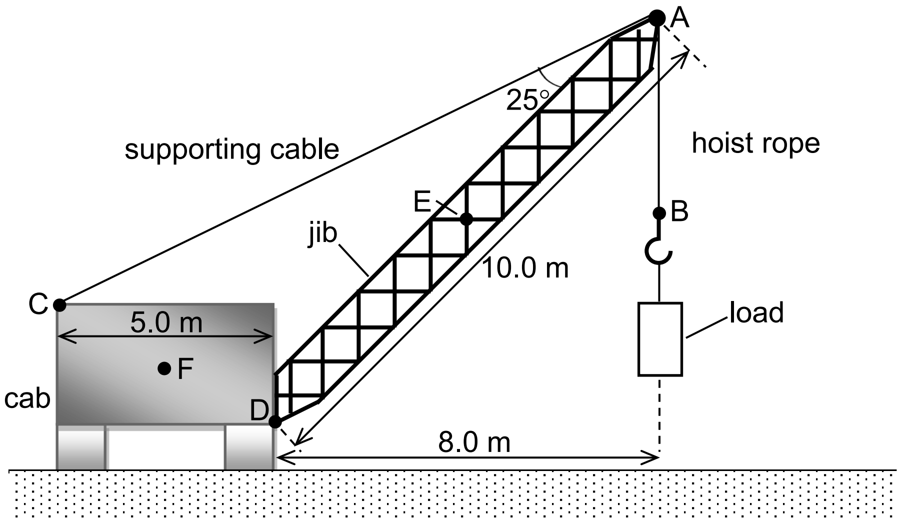

Fig. 4.1

When the load is lowered with a deceleration of 1.0 m s^{-2}, calculate

(i) the tension in the hoist rope AB,

tension in AB = ……………………………. N [2]

(ii) the corresponding tension in the supporting cable AC.

tension in AC = ……………………………. N [2]

(c) For the jib in the position shown in Fig. 4.1, there is a maximum load which will just topple the crane.

(i) On Fig. 4.1, label **G**, the point about which the crane will topple. [1]

(ii) Determine the maximum load which will just topple the crane.

maximum load = ... N [2]

(d) The load is a rectangular slab of concrete. Fig. 4.2 shows how the slab of concrete is hooked to rope AB of the jib.

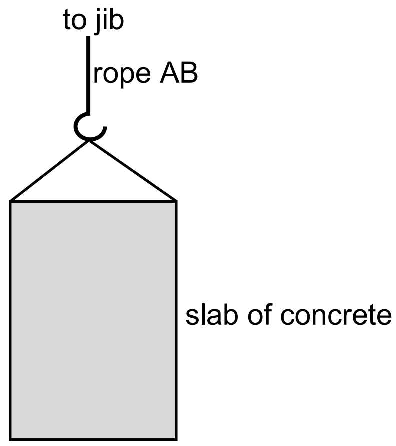

Fig. 4.2

Explain why the crane is more likely to topple on a windy day when carrying this slab of concrete.

....

....

....

.... [2]

[Total: 11]

5 **(a)** Distinguish between *gravitational* potential energy and *elastic* potential energy.

....

....

....

.... [2]

(b) A ball of mass 65 g is thrown vertically upwards from ground level with a speed of 16 m s^{-1}. Air resistance is negligible.

(i) Calculate, for the ball,

1. the initial kinetic energy,

kinetic energy = ... J [2]

2. the maximum height reached.

maximum height = ... m [2]

(ii) The ball takes time t to reach maximum height. For a time of $\frac{t}{2}$ after the ball has been thrown, determine the ratio

$$\frac{\text{potential energy of ball}}{\text{kinetic energy of ball}}$$

ratio = …………………………… [3]

(iii) State and explain the effect of air resistance on the time taken for the ball to reach maximum height.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

[Total: 11]

6 **(a)** Describe uniform circular motion with reference to the magnitude and direction of velocity and acceleration.

....

....

....

.... [2]

(b) Two cars are moving around a horizontal circular track. One car follows path X and the other follows path Y, as shown in Fig. 6.1.

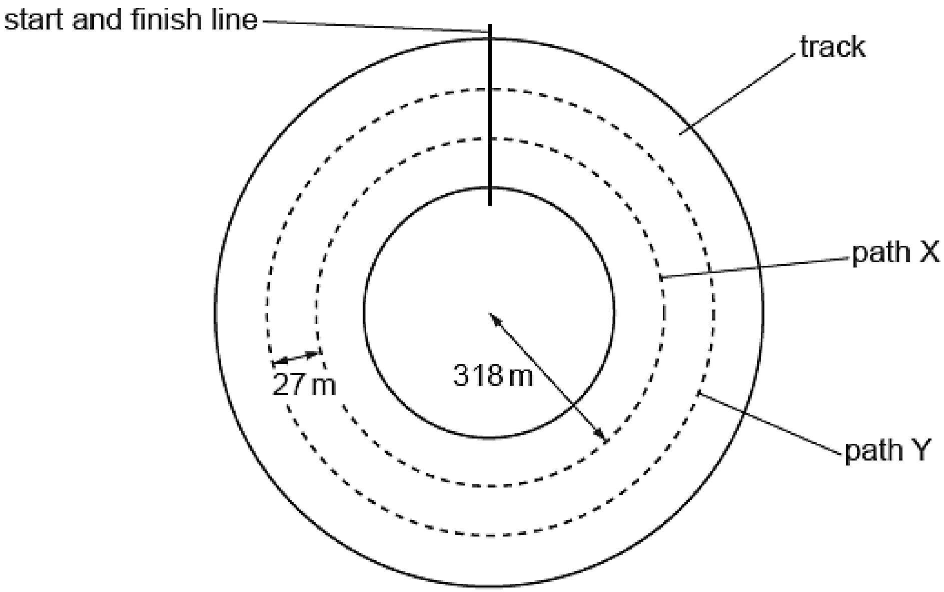

Fig. 6.1 (not to scale)

The radius of path X is 318 m. Path Y is parallel to, and 27 m outside, path X. Both cars have mass 790 kg. The maximum friction force *F* that the cars can experience without sliding is the same for both cars.

(i) The maximum speed at which the car on path X can move around the track without sliding is 94 m s^{-1}.

Calculate *F*.

F = ... N [2]

(ii) Both cars move around the track at their respective maximum speeds without sliding.

Complete Table 6.1, by placing one tick in each row, to indicate how the quantities for the car on path Y compare with the car on path X.

	Y less than X	Y same as X	Y greater than X
centripetal acceleration			
maximum speed			
time taken for one lap of the track			

[3]

Table 6.1

(c) A stone of weight 3.0 N is fixed, using glue, to one end P of a rigid rod CP, as shown in Fig. 6.2.

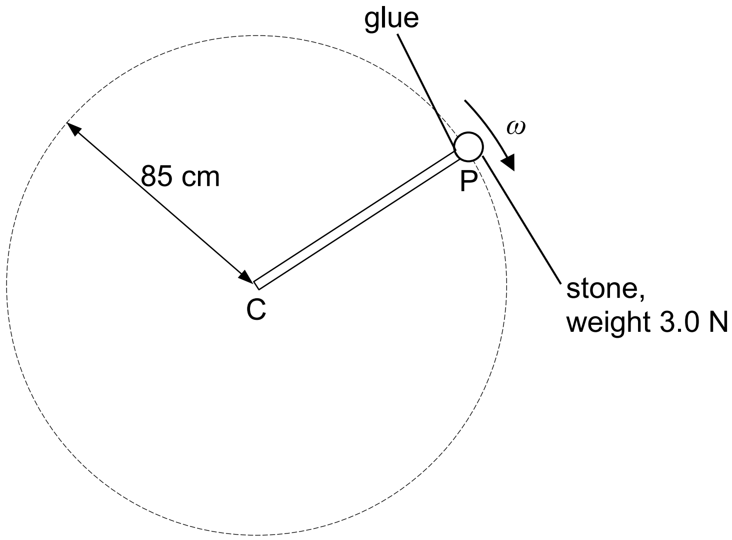

Fig. 6.2

The rod is rotated about end C so that the stone moves in a vertical circle of radius 85 cm.

The angular speed ω of the rod and stone is gradually increased from zero until the glue snaps.

The glue fixing the stone snaps when the tension in it is 18 N.

For the position of the stone at which the glue snaps,

(i) on the dotted circle of Fig. 6.2, mark with the letter S the position of the stone, [1]

(ii) calculate the angular speed ω of the stone.

angular speed ω = …………………………………….. rad s^{-1} [2]

[Total: 10]

END OF PAPER