Name: ________________________ (   ) CT Group: 23S0 ____

RAFFLES INSTITUTION

2022 YEAR 5 PROMOTION EXAMINATION

30 September 2022

H2 PHYSICS

Section B

INSTRUCTIONS TO CANDIDATES

Write your name, index number and CT Group.

Write your answers to Section B in the spaces provided in this booklet.

For Examiner's Use		
Section A	MCQ	/ 15
Section B	16	/ 10
	17	/ 10
	18	/ 9
	19	/ 11
	20	/ 10
Section C	21	/ 15
	22	/ 15
Deductions		
Total		/ 95

There are **13** printed pages, inclusive of the cover page, in this booklet

16 A man of mass 50 kg is standing in a lift that starts from rest on the ground floor at t = 0 s and rises to the top floor over a 10 s interval.

The acceleration a of the man changes with time t as shown in Fig. 16.1. The value of the acceleration at t = 9.0 s is q.

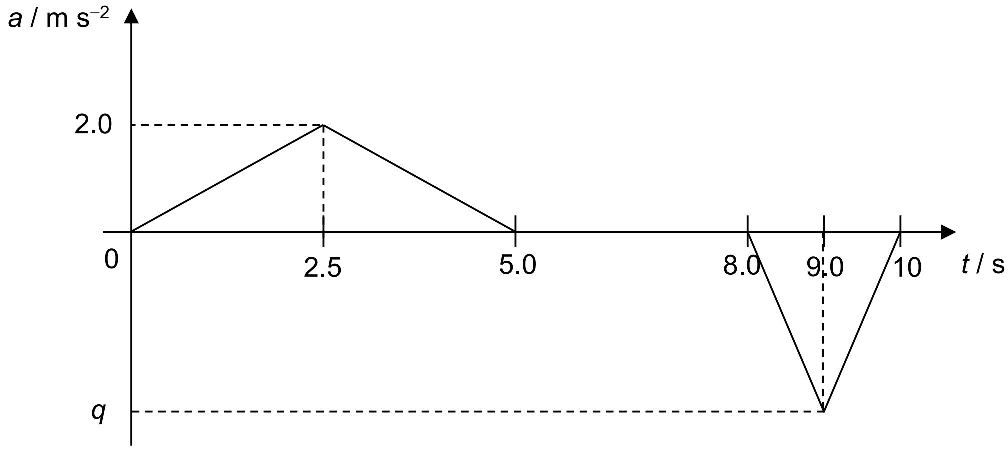

Fig. 16.1

(a) By considering the forces acting on the man, explain why the magnitude of q cannot exceed g, the acceleration due to free fall of the Earth.

....

....

....

.... [2]

(b) The man comes to rest at the top floor.

Determine q, the acceleration of the man at t = 9.0 s.

q = ... m s^{-2} [2]

(c) **(i)** On Fig. 16.2, sketch a graph to show how the velocity v of the man varies with time t. Label the vertical axis with appropriate values.

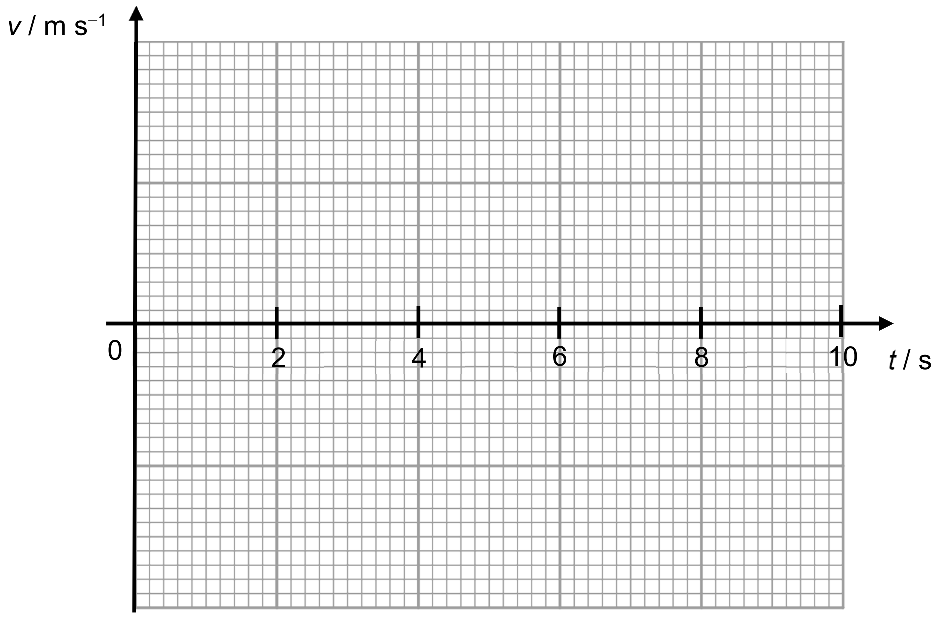

Fig. 16.2

[3]

(ii) Using your answer in **(c)(i)** or otherwise, calculate the distance travelled by the man during the first 5.0 seconds.

distance travelled = ... m [1]

(iii) Determine the work done by the normal contact force on the man during the first 5.0 seconds.

work done = ... J [2]

17 At the San Antonio Zoo, it is possible to have a tug of war battle with a lion cub. The lion enclosure is landscaped to mimic a savanna with uneven ground and grass. A light rope is passed through a hole in the glass wall of the lion enclosure, where on one end, a lion cub pulls on the rope, while the other end is pulled by a "contender" standing outside the enclosure on even concrete ground.

(a) In one such battle, the rope is held straight and horizontal between the lion cub and the man as shown in Fig 17.1 and the tension in the rope is 500 N.

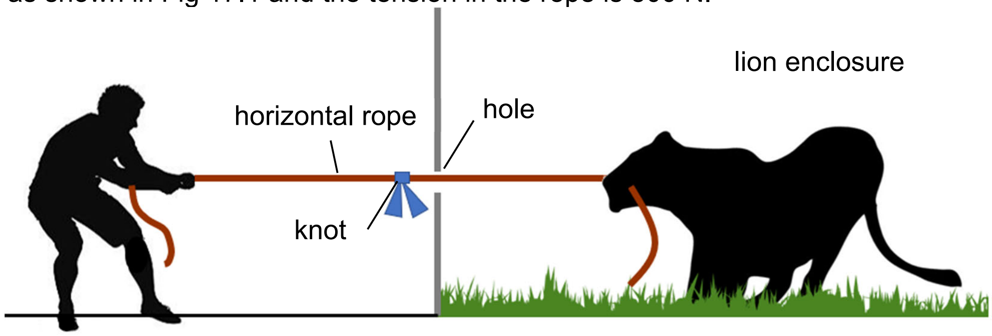

Fig. 17.1

(i) An observer states that there will be no winners in this battle since the rope exerts a force of 500 N on both the man and the lion, but in opposite directions. Comment on this statement.

....

....

....

....

....

.... [3]

(ii) The man changes his stance such that his centre of gravity is 0.50 m away from the tip of his toes as shown in Fig. 17.2, with the rope horizontal and 0.80 m above the ground. The man is about to topple forward when the tension is 500 N.

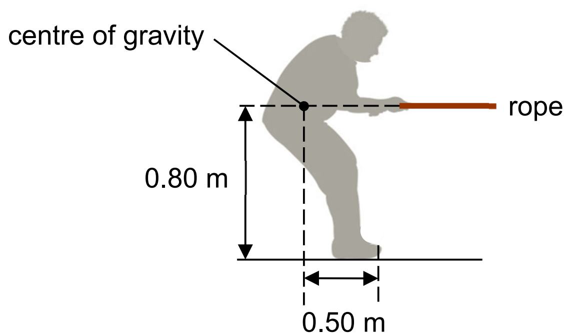

Fig. 17.2

1. Determine the mass of the man.

mass = ... kg [2]

2. If the tension in the rope increases, explain what the man can do to maintain a stable position.

....

....

.... [1]

(b) The zookeepers then reposition the man such that he now pulls at the rope at an angle of 25° to the glass enclosure wall using a fixed smooth vertical pole. Fig. 17.3 shows the cross-sectional view from the top.

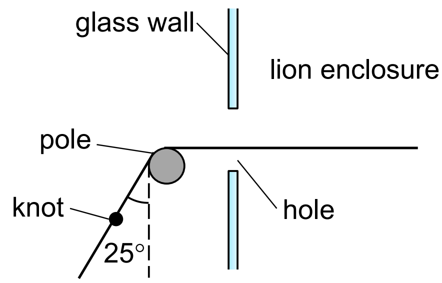

Fig. 17.3 (top view)

He now increases the tension to 1000 N and the rope is stationary.

Determine the magnitude and direction with respect to the glass wall of the reaction force *R* exerted on the rope by the pole.

magnitude of *R* = ... N

direction of *R* = ... [4]

18 In a stationary car, a cup of water with an ice cube is placed on the dashboard and a pendant is hang from the roof as shown in Fig. 18.1.

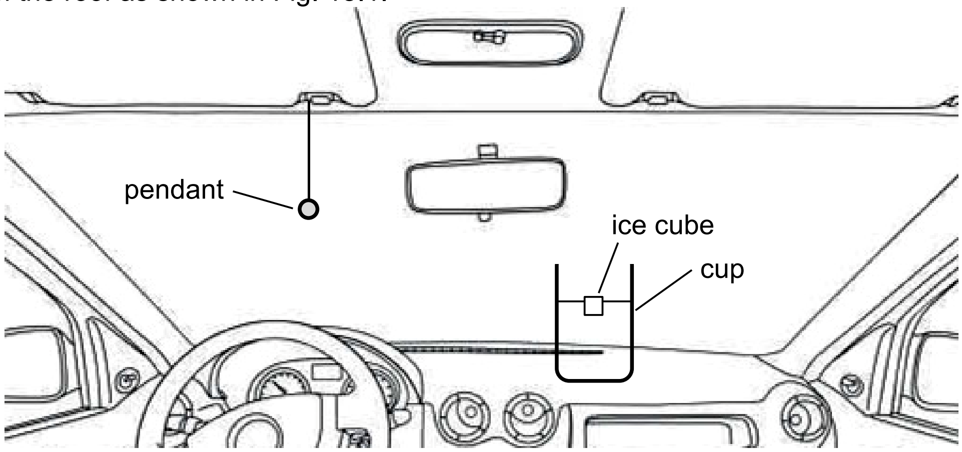

Fig. 18.1

The car makes a right turn along a circular path of radius 8.5 m on a horizontal road surface at a constant speed of 7.0 m s^{-1}. The plane of the water surface is inclined at an angle θ to the horizontal as shown in Fig. 18.2 while the pendant is inclined to the left at the same angle θ to the vertical as shown in Fig. 18.3.

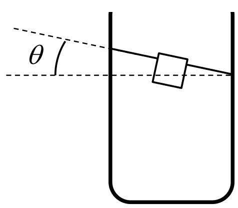

Fig. 18.2

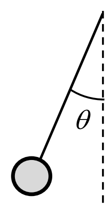

Fig. 18.3

(a) Explain how the centripetal force acting on the ice cube is produced.

....

....

....

.... [2]

(b) On Fig. 18.3, draw and label arrows to show the forces acting on the pendant.

[1]

(c) Determine

(i) the angular speed of the car,

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

(ii) the angle θ.

θ = ... ° [3]

(d) The car continues its right turn on a road surface that is banked at 10°, as shown in Fig. 18.4, with the same radius and speed.

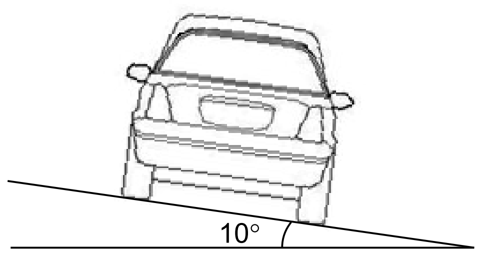

Fig. 18.4

State and explain what happens to angle θ of the pendant to the vertical.

....

....

....

.... [2]

19 A uniform spherical planet of mass 1.3×10^{22} kg and radius 1.2×10^{6} m has a uniform spherical moon with half the radius of the planet. Both the planet and its moon have the same density.

(a) Show that the mass of the moon is 1.6×10^{21} kg.

[1]

(b) Define *gravitational field strength*.

....

.... [1]

(c) Determine the magnitudes of the gravitational field strengths g_p and g_m on the surfaces of the planet and its moon respectively.

g_p = ... N kg^{-1} [1]

g_m = ... N kg^{-1} [1]

(d) The distance between the centres of the planet and its moon is 2.0×10^7 m.

(i) Determine the distance d from the centre of the planet and along the straight line joining both centres to the point where the resultant gravitational field strength g is zero.

d = ... m [2]

(ii) On the axes in Fig. 19.1, sketch the variation with distance of the resultant gravitational field strength g from the surface of the planet to the surface of its moon, along the straight line joining their centres.

Label the axes with appropriate values.

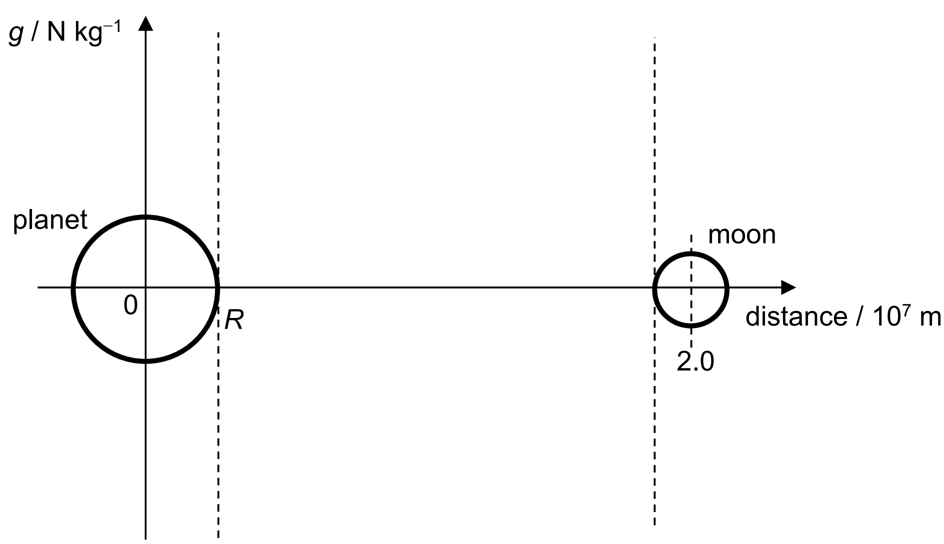

Fig. 19.1 [3]

(iii) A piece of rock of mass *m* is to be launched from the surface of the planet such that it will land on the surface of its moon.

Explain how your graph in Fig.19.1, if accurately drawn, may be used to determine the minimum amount of energy required to launch the rock.

....

....

....

.... [2]

20 A block moving with an initial speed of 2.0 m s^{-1} on a horizontal smooth surface collides with a horizontal spring, as shown in Fig. 20.1.

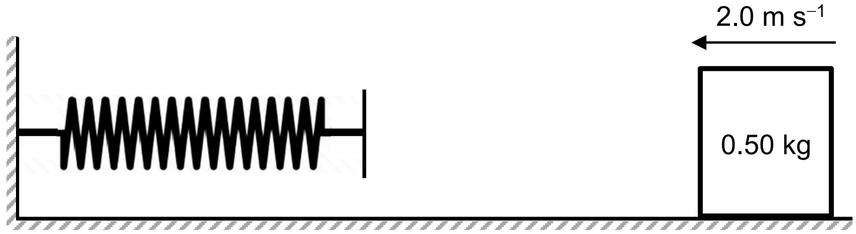

Fig. 20.1

The mass of the block is 0.50 kg, and the force constant of the spring is 50 N m^{-1}.

(a) Determine the maximum compression of the spring.

maximum compression = ... m [2]

(b) **(i)** Determine the time taken for the block to move from the point of contact to the point of maximum compression of the spring.

time = ... s [3]

(ii) Determine the magnitude of the acceleration of the block at the point of maximum compression of the spring.

acceleration = ... m s^{-2} [2]

(c) Take the initial point of contact between the block and the spring as zero displacement, and direction towards the left as positive.

(i) On the axes of Fig. 20.2, sketch the variation with displacement x of the velocity v of the block, from the moment of contact to the moment of maximum compression of the spring. Label the axes with appropriate values.

[2]

(ii) On the axes of Fig. 20.3, sketch the variation with displacement x of the acceleration a of the block, from the point of contact to the point of maximum compression of the spring. Label the axes with appropriate values.

[1]

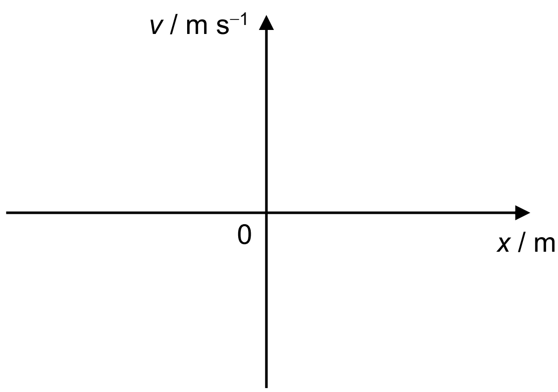

Fig. 20.2

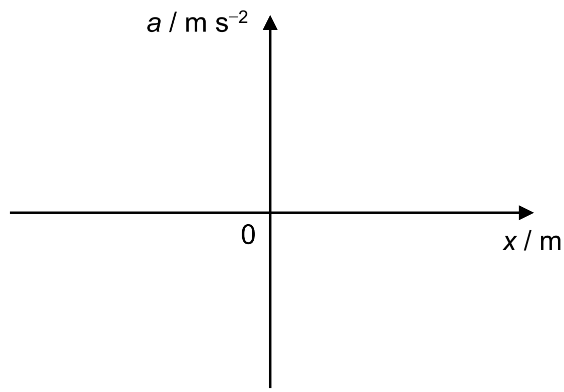

Fig. 20.3