STUDENT NAME

[redacted]

2016 Motion SAC

Unit 3 PHYSICS

Writing time: 45 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
Areas of study			
Motion	20	20	40
		Total:	40

Permitted materials
- Pens, pencils, highlighters, erasers, sharpeners, rulers
- One A4 sheet of pre–written notes which may be typed or handwritten on one side.
- One scientific calculator.

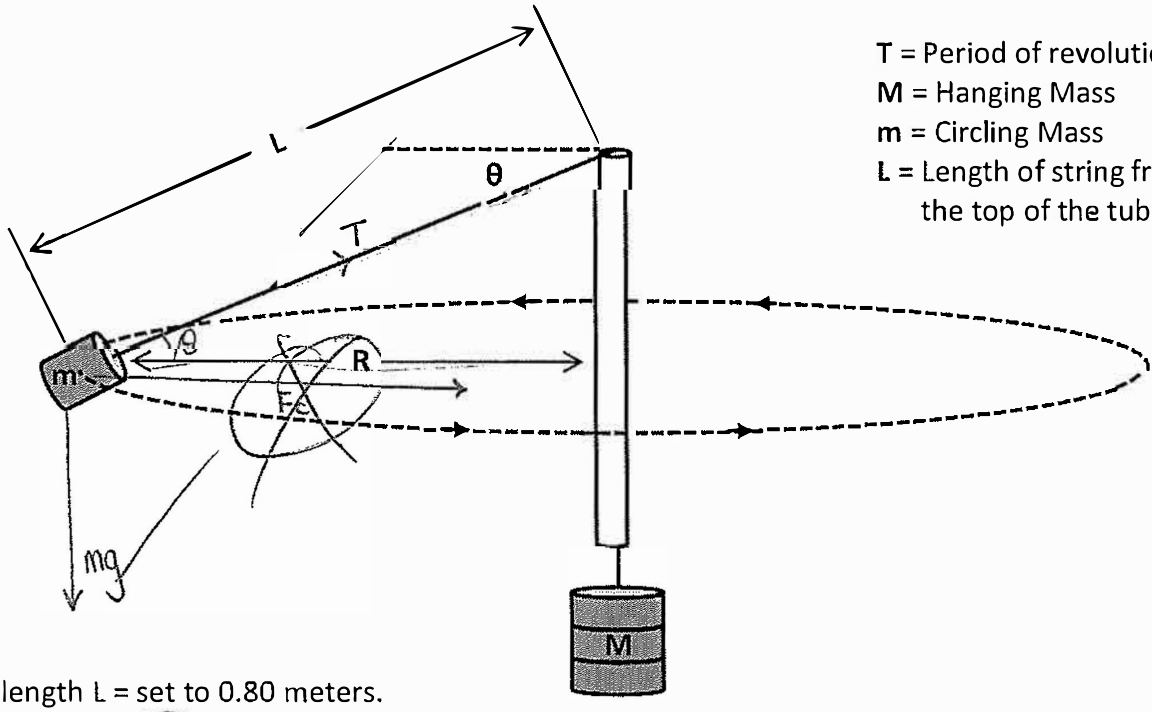
Materials supplied
- This question and answer book.

Instructions
- Don't look for an attached formula sheet – there isn't one. Use your own "summary sheet".
- Write your name in the space provided at the top of this page.
- Always show working where space is provided to avoid loss of marks.
- Write final answers in the boxes provided with each question.
- Where an answer box includes a unit, give your answer in this unit.
- All written responses must be in English.
- Invisible ink is not permitted.

Area of study 1 – Motion

- Assume the value **g=10** Nkg^{-1} for gravitational field strength in all questions.
- Ignore the effects of friction or air resistance unless otherwise specified.

The following equipment was used to investigate horizontal circular motion at a constant speed.
A smaller mass **m** is made to move in a horizontal circle by connecting it to a larger hanging mass **M** using a thin string as shown below.



T = Period of revolution
M = Hanging Mass
m = Circling Mass
L = Length of string from **m** to the top of the tube

The length L = set to 0.80 meters.
Initially the hanging mass **M** is adjusted to be equal to 3**m**.

Question 1

Draw the forces acting on the circulating mass **m**, in the diagram above and then calculate the angle Θ which the string makes with the horizontal. Answer to the nearest one tenth of a degree.

	Degrees	3 marks

Question 2

Calculate radius R. Round your answer to two decimal places.

R

	m	1 marks

Question 3

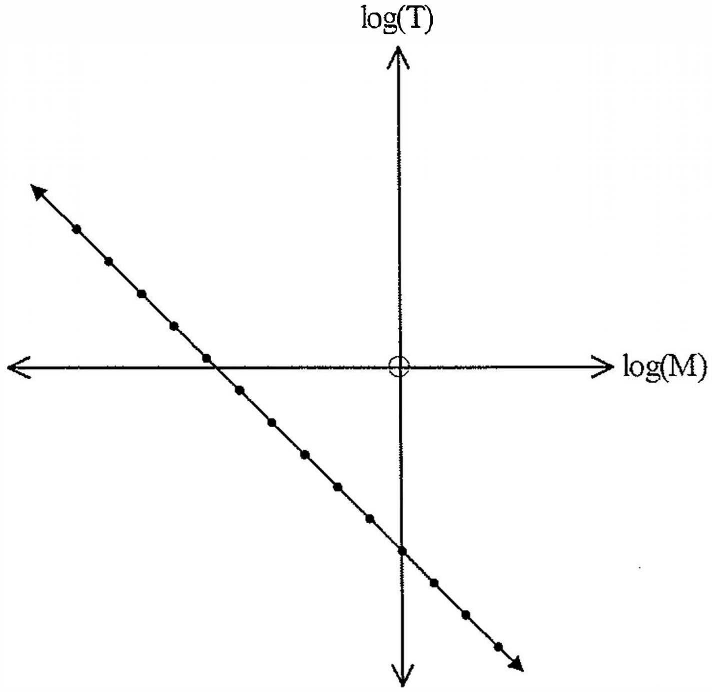
0·75 m

Calculate the time T (period) required for the smaller mass to complete one full revolution. Round your answer to 2 decimal places.

	s	2 marks

The same equipment is now used to systematically adjust the value of the hanging mass M and record the period T while keeping the length L constant at 0.80 meters.

This data was used to produce a graph of log(T) vs log(M) which produced a straight line as shown below.



Question 4

Which of the following statements concerning the gradient of the graph produced is correct?

A. The gradient of the graph should be equal to -2
B. The gradient of the graph should be equal to - $\sqrt{2}$
C. The gradient of the graph should be equal to -1

D. The gradient of the graph should be equal to - $\frac{1}{\sqrt{2}}$

E. The gradient of the graph should be equal to - $\frac{1}{2}$

B	2 marks

Question 5

Which of the following changes to the hanging mass M would result in the period T reducing to exactly half of its initial value?

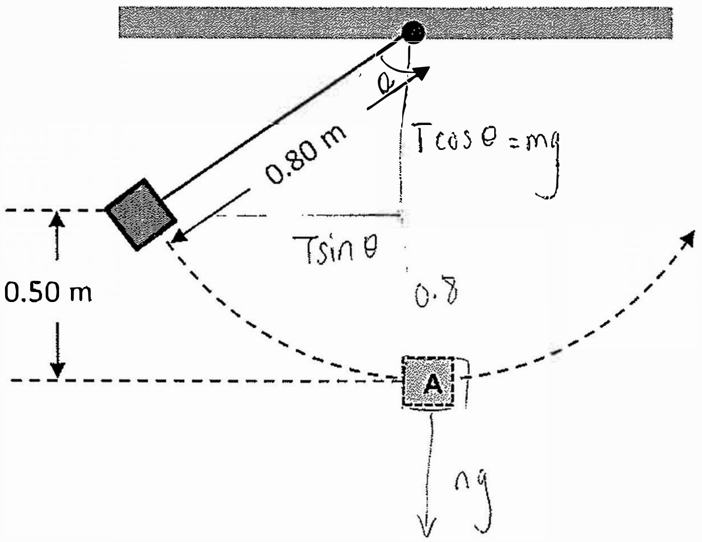
A. The hanging mass M is reduced to $\frac{1}{4}$ of its initial value.

B. The hanging mass M is reduced to $\frac{1}{2}$ of its initial value.

C. The hanging mass M is increased to 2 times its initial value.
D. The hanging mass M is increased to $\sqrt{2}$ times its initial value.
E. The hanging mass M is increased to 4 times its initial value.

E	2 marks

A 1.2 kg mass is connected from a string of length 0.80 m is attached to the roof is released from rest as shown below. The mass swings back and forth freely without any frictional resistance forces.



Question 6

Calculate the speed at which the mass is moving as it passes through position A at the lowest point in its path. Round your answer to one decimal place.

Loss GPE = gain KE

$mgh = \frac{1}{2}m(v^2-u^2)$

$V = \sqrt{2g\Delta h}$

$V = \sqrt{2 \times 10 \times 0.5}$

V = 3.2 m/s

2

3.2 ms^{-1}	2 marks

Question 7

Calculate the magnitude of the tension force acting in the string as the mass is moving as it passes through position A at the lowest point in its path.

$F_c = \frac{mv^2}{r}$

$T = F_c + W$

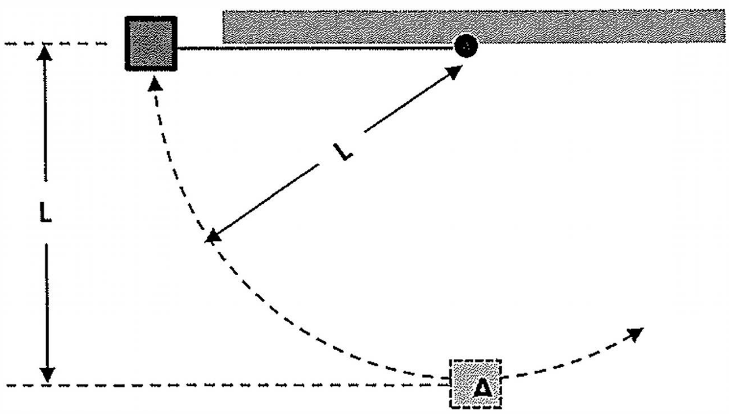
$T = \frac{1.2 \times 10}{\cos(51.34)}$

=

X

N	2 marks

In a similar situation to the previous question, a stationary mass **M** is now released from the top position as shown below. The mass swings back and forth freely without any frictional resistance forces.



As the mass passes through position A at the bottom of the path, the string has a tension force of magnitude **T**.

Question 8

If the string used was doubled in length from **L** to **2L** which of the following alternatives correctly describes the effect that this would have on the magnitude of the tension force in the string as it passes through position A at the lowest point in its path. Assume that the mass is always released from the top position.

A. The tension force at the bottom is $\frac{T}{2}$
B. The tension force at the bottom is $\frac{T}{\sqrt{2}}$
C. The tension force at the bottom is **T**
D. The tension force at the bottom is $T\sqrt{2}$
E. The tension force at the bottom is 2**T**

B	2 marks

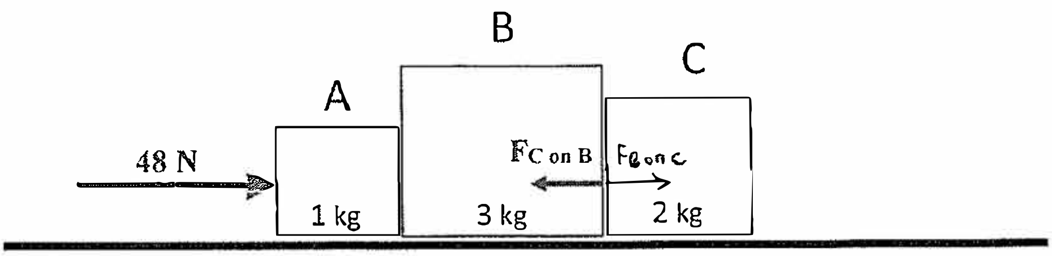
Question 9

The string length is changed back to its original length **L** and the mass is now doubled to 2**M**.
Which of the following alternatives correctly describes the effect that this would have on the magnitude of the tension force in the string as it passes through position A at the lowest point in its path. Assume that the height drop of the mass remains the same.

A. The tension force at the bottom is $\frac{T}{2}$
B. The tension force at the bottom is $\frac{T}{\sqrt{2}}$
C. The tension force at the bottom is **T**
D. The tension force at the bottom is $T\sqrt{2}$
E. The tension force at the bottom is 2**T**

E	2 marks

Three blocks A, B and C are being accelerated by a 48 N force along a horizontal frictionless surface as shown below. The mass of each block is shown on the diagram.



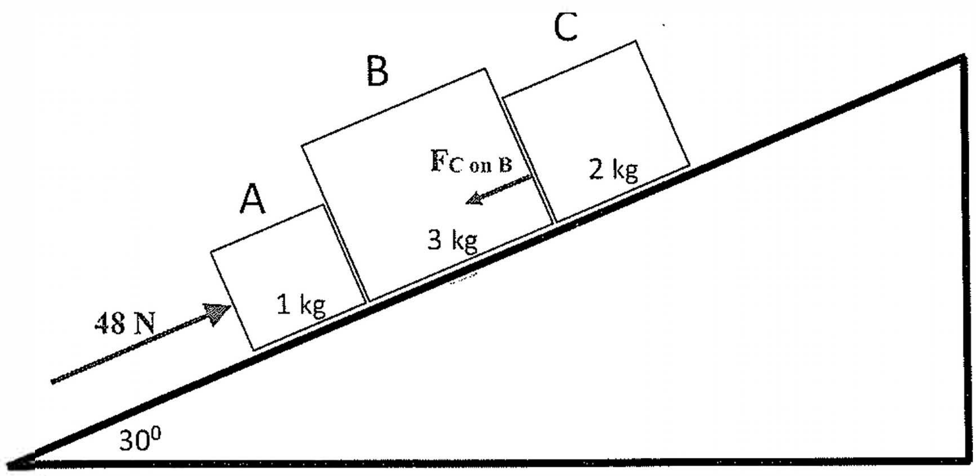
Question 10

Calculate the size of the force which block C applies to block B.

6 =

N	2 marks

The system of blocks is now inclined at an angle of 30^0 to the horizontal and is still being accelerated along the frictionless surface by the 48 N force as shown below.



Question 11

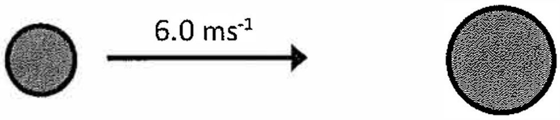
Calculate the size of the force which block C now applies to block B.

6 N	2 marks

Questions 12 to 14 refer to the following situation

A 0.16 kg ball travelling with an initial velocity of 6.0 ms^{-1} rightwards, collides with a stationary 0.32 kg ball as shown below. 0.32 kg ball moves rightwards at 3.5 ms^{-1} after the collision.

Initial:



Final:

Question 12

Calculate the speed of the 0.16 kg ball after the collision.

	ms^{-1}	2 marks

Question 13

Using appropriate calculations determine if the collision is elastic.

Appropriate Calculations:		
Momentum is conserved.		
Elastic (circle correct answer):	YES NO	2 marks

Question 14

Which of the following statements regarding total Momentum and Kinetic Energy during the collision is correct?

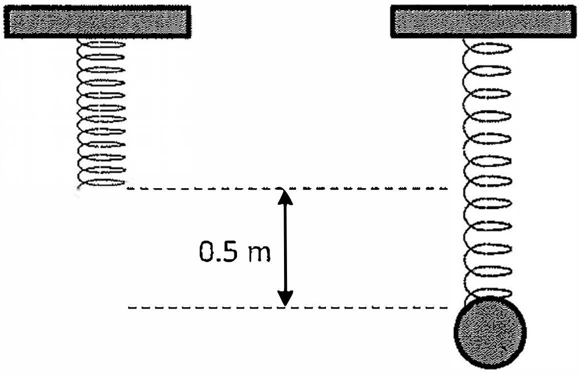
A. The total Momentum and total Kinetic Energy are both conserved during the collision.
B. The total Momentum is conserved and the total Kinetic Energy is not conserved during the collision.
C. The total Momentum is not conserved and the total Kinetic Energy is conserved during the collision.
D. The total Momentum is not conserved and the total Kinetic Energy is not conserved during the collision.
E. Some of the Kinetic Energy is converted into Momentum during the collision.

B	2 marks

2

Questions 15 to 16 refer to the following situation

A 2.5 kg mass is suspended from a spring causing the spring to extend by 0.50 m without any bouncing as shown below. The mass is in equilibrium at this new position.



Question 15

Calculate the value of the spring constant.

$mg = kx$

$2.5 \times 10 = k \times 0.5$

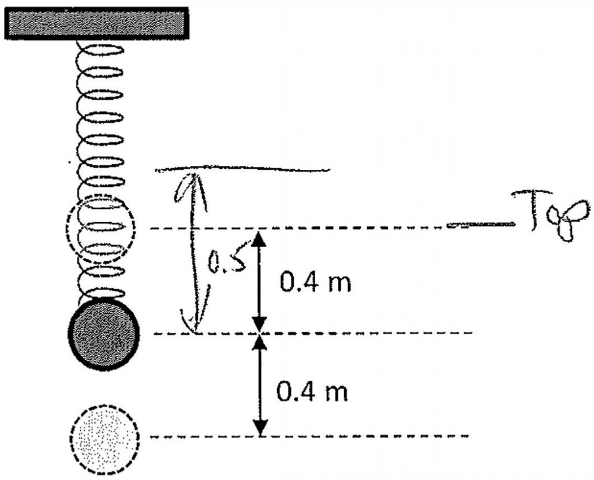
$k = 50\ Nm^{-1}$

50 Nm^{-1}	2 marks

2

Question 16

The mass is then pulled down a further 0.4 m and released so that it moves up and down in an oscillating motion with amplitude 0.4 m as shown below.



Calculate the maximum speed of the mass during the oscillating motion.
Round your answer to one decimal place.

TOP

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

$\frac{1}{2}(50)(0.1)^2 + 2.5 \times 10 \times 0.8 = \frac{1}{2} \times 2.5 \times v^2 + 10 \times 2.5 \times 0.4 + \frac{1}{2} \times 50 \times 0.5^2$

$20.25 = 1.25v^2 + 10 + 4.25$

$v^2 = \frac{6}{1.25}$

$v = \sqrt{4.8}$

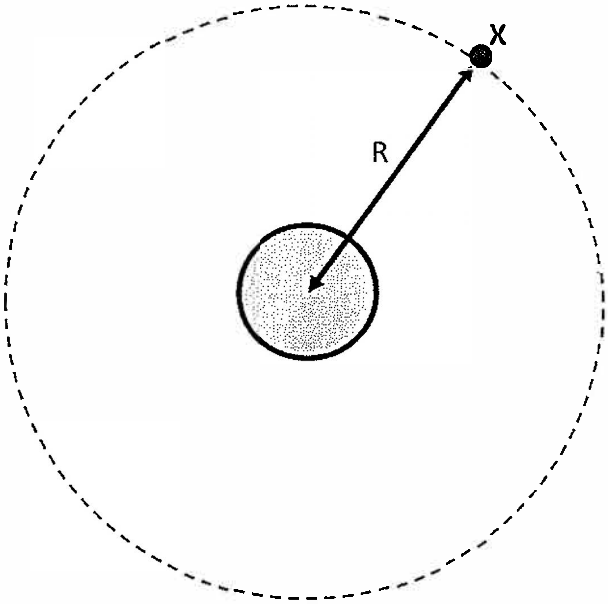
$v = 2.2\ ms^{-1}$

2.2 ms^{-1}	2 marks

1

Questions 17 to 18 refer to the following situation

A satellite **X** orbits a planet with an orbital radius R at as shown below.



The mass of the of the planet is 8.50×10^{24} kg and the satellite takes 15.0 hours to complete one orbit.

Question 17

Calculate the radius of the orbit. (use $G = 6.67 \times 10^{-11}$ Nm^{2}kg^{-2})
Express your answer in km to the nearest 100 km.

R =

2

	2 marks

Question 18

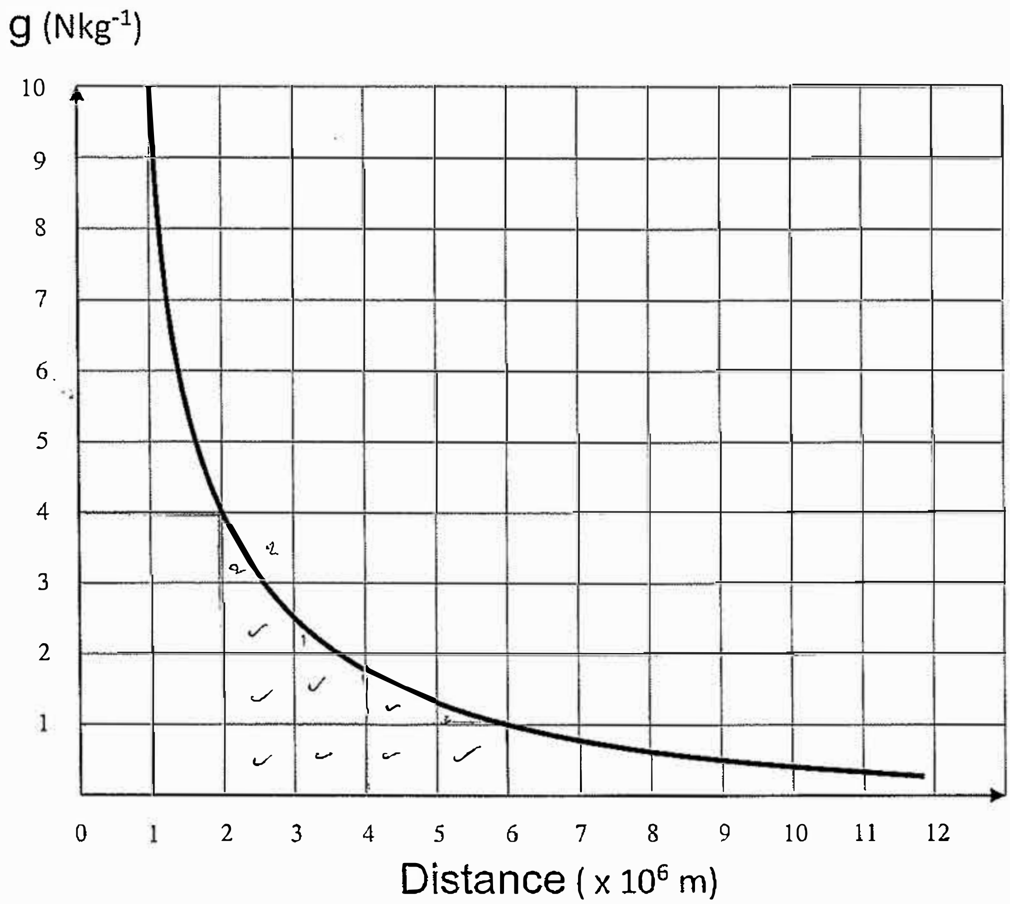
Calculate the acceleration of the satellite.
Round your answer to two decimal places.

2

0·47 ms^{-2}	2 marks

Questions 19 to 20 refer to the following situation

The gravitational field strength vs distance from the centre of a planet of radius 2000 km is shown graphically below.



A 1500 kg meteor at a distance of 6000 km from the centre of the planet is initially moving with a speed of 3000 ms^{-1} as it falls towards the planet.

Question 19

Calculate the loss in gravitational potential energy of the meteor as it falls to the surface of the planet. Express your answer in scientific notation to two significant figures (e.g. 3.8×10^{10} J)

	2 marks

Question 20

Calculate the speed of the meteor as it strikes the surface of the planet. Ignore air resistance.

	ms^{-1}	2 marks