University of Nottingham
UK | CHINA | MALAYSIA

UNNC ONLINE EXAMINATIONS COVER SHEET

1. Please fill in the information below before starting your examination.

STUDENT NAME: Changyu Li

STUDENT ID NUMBER: 20513997

DATE: 04/01/2023

YEAR OF STUDY: Y1

MODULE TITLE: Foundation Science A

MODULE CODE: CELEN039

Question No.	Mark

2. Before starting the examination, read the instructions given to you carefully.

3. You must show to the invigilator all sheets of paper you brought to the examination to demonstrate that they do not contain any unauthorized information.

4. All rough work must be shown, and must be crossed out before photographing and uploading your answer.

5. ALL used sheets of paper brought with you to the examination MUST be uploaded as part of your answer.

6. Clearly indicate where you start to answer a new question.

7. If you need to use the toilet, you MUST indicate the time that you leave AND the time that you return **on the page you are using at that moment**.

8. At the end of the examination, you will be given extra time to collect your phone, photograph/scan your answers, upload those scans/photographs to your computer and then submit them to the examination website. You may NOT do so before the end of the examination.

Question Number

Q.1

(a) Power is the rate that energy is transferred.

(b) P is defined as the rate energy transferred
since work W is a measure of energy. the rate P
can be cauculated by W divided by time t.

$P = W \div t$

since the car is travelling with constant speed v.
the work done W can be cauculated by

$W = Fd = F(vt)$

$P = W \div t = F(vt) \div t = Fv.$

$P = Fv$

(c)

i) the distance car travelled is 4.8km and the speed is 16m/s
the time the car takes is $4.8km \div 16m/s$
$= 300\ s$

ii) the distance of the gravitational force is 0.30km
the gravity $G = 1.2 \times 10^4\ N$

the work done against the gravitational force is.

$W = Fd = 1.2 \times 10^4\ N \times 300m$
$= 3.6 \times 10^3\ J.$

iii) Work done W = work against gravity W_1 + work against friction W_2
by ii), $W_1 = 3.6 \times 10^3\ J$
work done to overcome friction is. $W_2 = F \times d$
$= 5.2 \times 10^2\ N \times 0.3km$
$= 2.4 \times 10^3 J$

Question Number

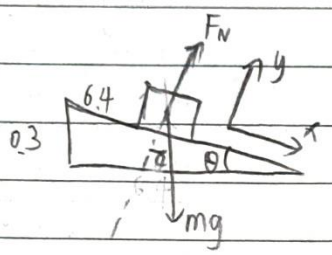
the total work is $W = W_1 + W_2 = 6\times10^3$ J.

$P = W \div t$ by i), $t = 300$ s

$= 6\times10^3$ J $\div 300$ s

$= 20$ W

(d) i)



as shown in free-body diagram the car don't move in y direction so the net force in y direction should be 0. the net force in x direction causes the acceleration.

$\sin\theta = \frac{0.3}{6.4} = \frac{3}{64}$

acceleration $a = F_x \div m$

$= mg \times \sin\theta \div m = g \times \sin\theta$

$= 9.81 \times \frac{3}{64}$

$= 0.50\ m/s^2$

ii) $d = v_0 t + \frac{1}{2} a t^2$

$v_0 = 0$ $\quad d = \frac{1}{2} a t^2$

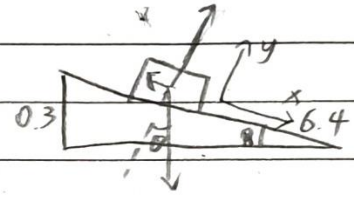
$t = \sqrt{\frac{2d}{a}}$

$= \sqrt{\frac{12800}{0.5}} = 160$ s

$v = at$

$= 160 \times 0.5 = 80$ m/s

iii) use the free-body diagram we can know that the net force is zero in the x direction.



$\sin\theta = \frac{0.3}{6.4} = \frac{3}{64}$

$f = mg\sin\theta$

$= 1.2\times10^4\ N \times \frac{3}{64}$

$= 562.5$ N

(e)

i) heat needed $Q = 340m$ kJ

the kinetic energy $E_k = \frac{1}{2}mv^2$

to just melt the ice, $E_k = Q$

$\frac{1}{2}mv^2 = 340m$

$v = \sqrt{680} = 26.08$ m/s

ii) as the hailstones are easy to reach 26.08 m/s.

if the tempreature of the hailstones are close enough to zero they will be likely to melt on hitting.

Question Number

Q.2

(a) i) (165 s, 0°C)

ii) the temperature remains 0°C during the phase change process. the energy is added in the form of heat. This energy is used to cause molecuces to viberate more rapidly. to make the ice transform to water.

iii) the mass of water is 0.25kg.
in 30 seconds, these 0.25kg water increased 15K
$Q = 4200\ J/kg.K \times 15K \times 0.25kg$
$= 15750J$
$P = Q \div t = 15750\ J \div 30s$
$= 525W \approx 530W$

iv) in 15 seconds, these 0.25 kg ice increased 20K
heat capacity $C = Q \div (m\Delta T)$
$= 525W \times 15s \div (0.25 \times 20)$
$= 1575\ J/kg.K$

v) the ice melts in 150 seconds
the latent heat $= P \times t$
$= 525W \times 150s$
$= 78750\ J$

(b) First choose a unit for the scale such as (°C)
then choose the liquid to be used in the scale.
Inject the liquid into a glass bobble which connected to a fine tube
When the temperoture increases. the liquid will expand into the tube, and the scale can be read.

University of Nottingham
UK | CHINA | MALAYSIA

(c) ① the person taking the temperature may not use it correctly.
② the temperature of the thermometer would not be same with the object under test. that would change the temperature of the object to be measured.
③ the environment would affect the reading, such as the sunlight

(d) heat capacity is the amout of heat that using to increase certain temperature of a unit mass of a substance. different substances have different heat capacity and it does not change with mass or temperature

(e) i) $\Delta T = 15\ K$

$L = 50. \times (1 + 15 \times 1.2 \times 10^{-5}) = 50 \times 1.00018$

$= 50.009\ m$

ii) the tape is longer than normal
so the true distance should be longer than readings.

$d = 35.794 \times 1.00018$

$= 35.800\ m$

University of Nottingham
UK | CHINA | MALAYSIA

Q4

(a) at first the Force $F_1 = \frac{k q_1 q_2}{r^2}$ $-0.108 = \frac{k q_1 q_2}{0.25} = 4k q_1 q_2$

when the spheres connected, the charge $q_3 = \frac{q_1 + q_2}{2}$ $F_2 = \frac{k q_3^2}{r^2}$ $0.36 = \frac{k(q_1+q_2)^2}{0.25 \times 4}$

$= k(q_1+q_2)^2$

$$\begin{cases} 4k q_1 q_2 = -0.108 \\ k(q_1+q_2)^2 = 0.36 \end{cases} \Rightarrow |q_1+q_2| = 6.328 \times 10^{-6} \quad k(q_1-q_2)^2 = 0.468$$

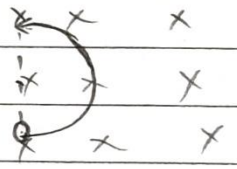
$|q_1 - q_2| = 7.215 \times 10^{-6}$

assume q_1 is negative q_2 is positive

$q_1 = -4.435 \times 10^{-7}$ C $\quad q_2 = 6.7715 \times 10^{-6}$ C

(b) i) $F = qVB$ the direction is pointing up

ii) the path is a semicircle



iii) $r = \frac{mv}{qB} = \frac{1.67 \times 10^{-27} v}{q B}$

iv) the direction of the electric field should be downward.

$F = qE = qvB$

$\therefore E = v \cdot B$

(c) use the right hand rule to know that the force is pointing vertical paper side outward

the $F = BILsin\theta = 0.8 \times 10 \times 0.10 \times \frac{\sqrt{2}}{2}$

$= \frac{2\sqrt{2}}{5} = 0.567$ N