FUKIEN SECONDARY SCHOOL
S4 First Term Examination (2020-2021)
Physics
(1 hour 30 minutes)

Date: 8th January 2021 Name: ______________________

Time: 10:30a.m. – 12:00nn Class: __________ No.:________

Instructions to students:

1. Write your name, class and class number on both the question paper and the answer sheets.
2. Answer ALL questions.
3. Write down all the answers on the answer sheets.
4. Hand in the question paper and the answer sheets at the end of the examination.
5. The total mark of the paper is 90.
6. The paper consists of two sections: Section A Multiple Choice Questions (30 marks) and Section B Structured Questions (60 marks).
7. The numerical answers should be either exact or correct to 3 significant figures.
8. You may use the following formula and data.

Data

Specific heat capacity of water	$c = 4200$ J kg^{-1} °C^{-1}
Specific latent heat of fusion of water	$l_f = 3.34 \times 10^5$ J kg^{-1}
Specific latent heat of vaporization of water	$l_v = 2.26 \times 10^6$ J kg^{-1}
Molar gas constant	$R = 8.31$ J mol^{-1} K^{-1}
Avogadro constant	$N_A = 6.02 \times 10^{23}$ mol^{-1}
Acceleration due to gravity	$g = 9.81$ m s^{-2} (close to the Earth)

Formula

$E = m\,c\,\Delta T$	energy transfer during heating and cooling
$E = l\,\Delta m$	energy transfer during change of state
$pV = nRT$	equation of state for an ideal gas
$pV = \frac{1}{3}Nm\overline{c^2}$	kinetic theory equation
$E_k = \frac{3RT}{2N_A}$	molecular kinetic energy

For uniformly accelerated motion:

$$v = u + at$$

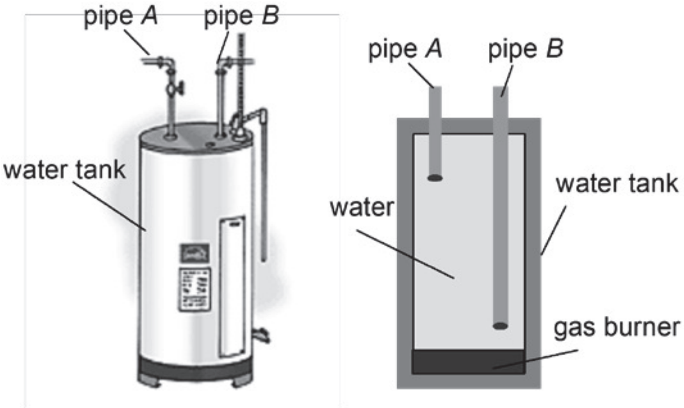
$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Section A: Multiple Choice Questions (30 marks)

1. A student is calibrating an ungraduated liquid-in-glass thermometer. The lengths of the liquid column are 40 mm and 160 mm at ice point and steam point respectively. What is the temperature when the length of the liquid column is 16 mm?
   A. −24 °C
   B. −20 °C
   C. −16 °C
   D. −12 °C

2. The following diagram shows the internal structures of a gas water heater. A gas burner is located at the bottom of the tank and there are two pipes to let the cold water into the tank and hot water out of the tank separately.

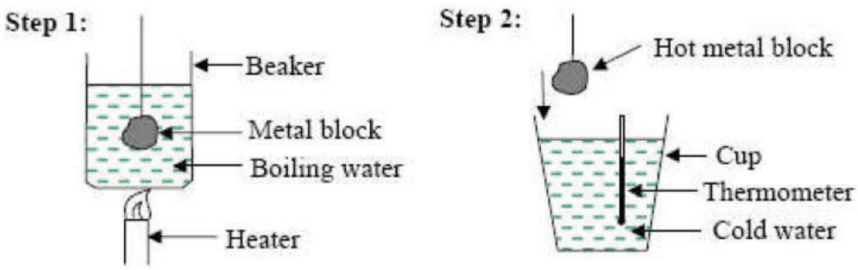


A water heater The internal structure

   Which of the following statements is/are correct?
   (1) Heat is transferred within the water mainly through convection.
   (2) Pipe *A* lets the cold water in and pipe *B* lets the hot water out.
   (3) Pipe *A* lets the hot water out and pipe *B* lets the cold water in.
   A. (2) only
   B. (3) only
   C. (1) and (2) only
   D. (1) and (3) only

3. In an experiment, 2 kg of water at 20 ºC is heated inside a boiler for 20 minutes. Water is boiled to 100 ºC and 1.7 kg of water remains after boiling. What is the estimated power of the boiler?
   A. 565 W
   B. 649 W
   C. 1125 W
   D. 3762 W

4. The specific heat capacity of a metal is measured using the following method.



A metal block is first immersed in boiling water for some time. The block is then transferred to a cup of cold water. After a while, the temperature of the water is measured. The result obtained is found to be higher than the true value of the specific heat capacity of the metal. Which of the following is a probable reason?

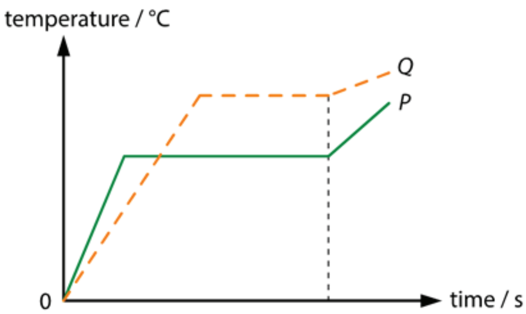
A. Some hot water is still adhered to the metal block when the block is transferred to cold water.

B. Some energy is lost to the surroundings when the metal block is transferred to cold water.

C. Some energy is absorbed by the cup.

D. The temperature of the metal block is still higher than the water when the final temperature of the water in the cup is measured.

5. Two substances *P* and *Q*, both in solid form initially, are heated up by two heaters of equal power. The figure shows how their temperatures vary with time.



Which of the following statements about *P* and *Q* must be correct?

(1) *P* has a lower melting point than *Q*.

(2) The solid form of *P* has a smaller heat capacity than that of *Q*.

(3) *P* has a larger specific latent heat of fusion than *Q*.

A. (1) and (2) only

B. (1) and (3) only

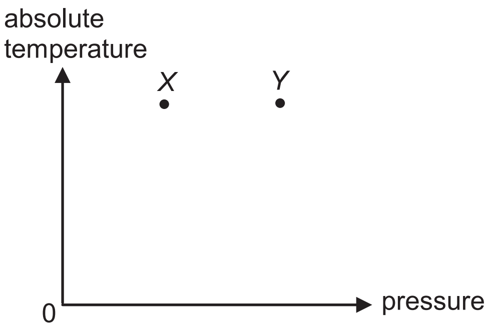
C. (2) and (3) only

D. (1), (2) and (3)

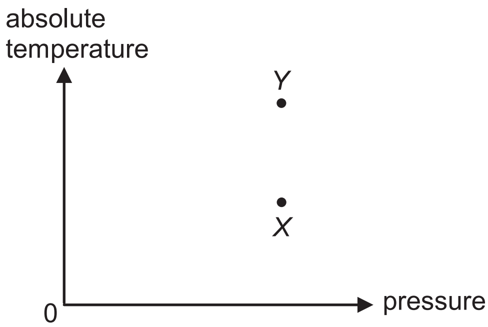
6. A certain mass of oxygen occupies a volume of 0.02 m^3 at atmospheric pressure (100 kPa) and 5 °C. Find its volume if it is heated up to 30 °C and its pressure is increased to 108 kPa.
   A. 0.0170 m^3
   B. 0.0202 m^3
   C. 0.0231 m^3
   D. 0.1111 m^3

7. A rigid sealed bottle contains an ideal gas at atmospheric pressure. Then the bottle is cooled in a refrigerator. After several hours, the bottle is taken out of the refrigerator. If *X* denotes the moment when the bottle is taken out of the refrigerator and *Y* denotes the moment when the steady state is reached, which of the following graphs best shows the states of the gas inside the bottle at these two moments?

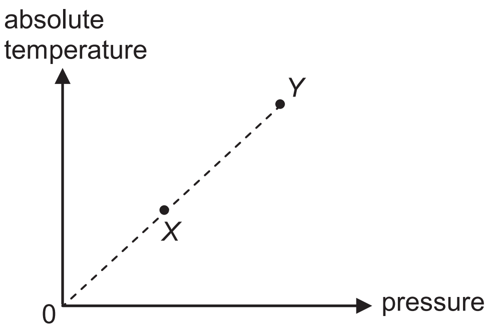
A.



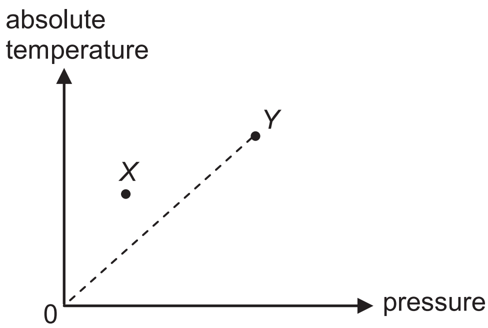
B.



C.

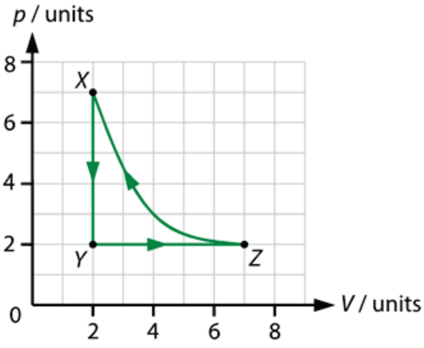


D.



8. Suppose the density of some hydrogen gas at pressure of 2.0×10^5 Pa and a temperature of 50 °C is 0.15 kg m^{-3}. Find the root mean-square speed of the hydrogen molecules under these conditions.
   A. 6.7×10^2 m s^{-1}
   B. 2.0×10^3 m s^{-1}
   C. 4.0×10^3 m s^{-1}
   D. 1.2×10^4 m s^{-1}

9. A fixed mass of an ideal gas is contained in a well-insulated cylinder. It undergoes changes along the paths shown in the pressure–volume (p–V) graph below.



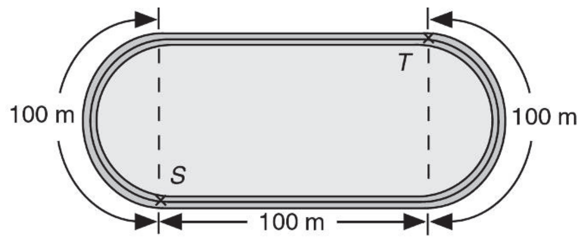
Which of the following statements are correct?

(1) From X to Y, the gas molecules hit the wall of cylinder less frequently.
(2) From Y to Z, the average kinetic energy of the gas molecules increases.
(3) From Z to X, the temperature of the gas remains unchanged.

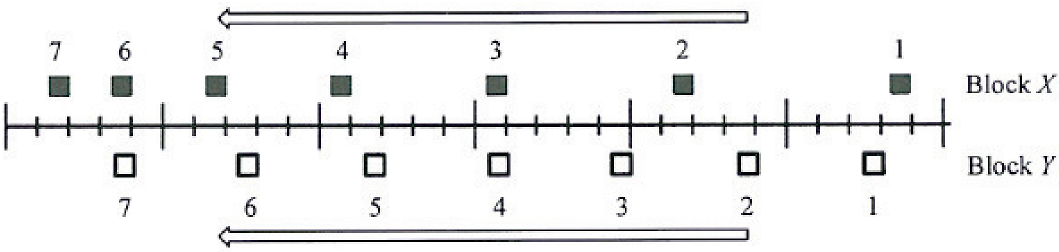
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

10. In a 1-km run, a student starts from S and ends at T as shown in the following figure. What is the magnitude of his displacement?

A. 104 m
B. 119 m
C. 200 m
D. 1000 m



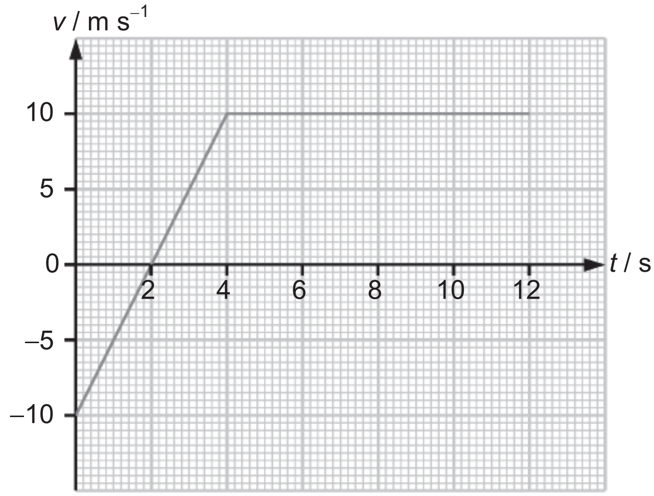
11. Two blocks X and Y are moving towards the left. Their positions at successive instants (indicated by the numbers) of equal time intervals are shown below.



Do these two blocks ever have the same instantaneous speed?

A. Yes, at instant 3.
B. Yes, at a moment between instants 4 and 5.
C. Yes, at instant 6.
D. No.

12. The velocity–time (v–t) graph of a car travelling on a straight road is shown below.



What is the average velocity of the car from $t = 0$ to $t = 12$ s?

A. 6.67 m s^{-1}

B. 7.50 m s^{-1}

C. 8.33 m s^{-1}

D. 10.0 m s^{-1}

13. A particle is moving along a straight line with uniform acceleration. It takes 2 s to travel a distance of 10 m and then 2 s to travel the next 18 m. What is its acceleration?

A. 0.88 m s^{-2}

B. 1.75 m s^{-2}

C. 1.87 m s^{-2}

D. 2.00 m s^{-2}

14. A stone falls freely from rest under gravity. If it travels a distance y in the 1st second, what is the distance it travelled in the **2nd second**?

A. y

B. $2y$

C. $3y$

D. $4y$

15. If there is no air friction, a raindrop falls freely from rest under the action of gravity from the cloud 1800 m above Hong Kong can have incredible speed. What is the speed of a raindrop before it hits the ground?

A. 70 m s^{-1}

B. 170 m s^{-1}

C. 190 m s^{-1}

D. 340 m s^{-1}

End of Section A

Section B: Structured Questions (60 marks)

1. A cup of water at 50 °C is mixed with another cup of unknown liquid. The mass of water is 100 g and that of the unknown liquid is 500 g. The final temperature of the mixture is 70 °C. (Specific heat capacity of the unknown liquid = 1500 J kg^{-1} °C^{-1})
   (a) How do the molecular kinetic energy, molecular potential energy and internal energy of the water change after mixing? (3 marks)
   (b) Before mixing, what is the temperature of the unknown liquid? State the assumption you have made. (3 marks)

2. A cup containing 100 g of boiling water is placed into a refrigerator.
   (a) Suppose the refrigerator takes away 500 J of energy from the water each minute. Find the time required for the water to change into ice completely. (3 marks)
   (b) In practice, it is found that the time taken for the water to change to ice is shorter than the calculated value in (a). Give a reason and explain briefly. (2 marks)
   (c) State one similarity and difference between boiling and evaporation. (2 marks)

3. Leo designs a solar cooker and places it under an electric lamp to test the cooker's ability in absorbing energy. The light from the lamp falls on the blackened pot and the water inside is heated up as shown in Figure 3.

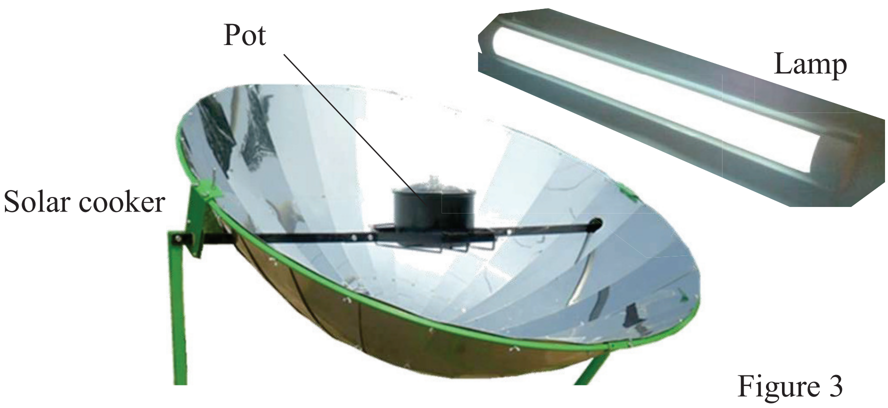


Figure 3

   (a) Name the process by which energy is transferred from the lamp to the pot. (1 mark)
   (b) State and explain how the temperature change in water differs in the following cases.
      (i) The outer surface of the pot is painted white. (2 marks)
      (ii) The pot is replaced by another pot with higher heat capacity. (3 marks)

4. A student carries out an experiment to investigate the relation between the pressure and volume of a gas using the apparatus as shown in Figure 4. The temperature of the gas is kept constant and is equal to the room temperature.

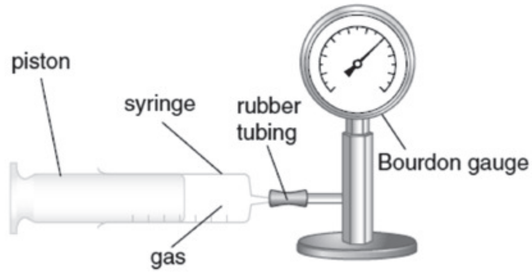


Figure 4

The experiment results are shown in the table below

Gas volume in syringe, V (cm^3)	30	25	20	15	10
Pressure, P (kPa)	84	100	118	163	235

(a) State ONE experimental precaution for keeping the gas temperature constant. (1 mark)

(b) (i) Plot a graph of $1/P$ against V. (5 marks)

(ii) What does the graph show? (1 mark)

(c) If the experiment is repeated at a lower room temperature using this set-up with the same mass of the same gas. Sketch the expected graph in the graph plotted in (b)(i). (2 marks)

5. The two diagrams below show how gas can be removed from a vessel by a vacuum pump. When the piston moves up, the gas in the vessel flows into the chamber C (Figure 5a). When the piston moves down, all the gas in C is expelled to the surroundings (Figure 5b). The volume of the vessel is 0.04 m^3 and the full volume of C is 0.01 m^3. Assume that the temperature of the gas is kept fixed and the gas is ideal.

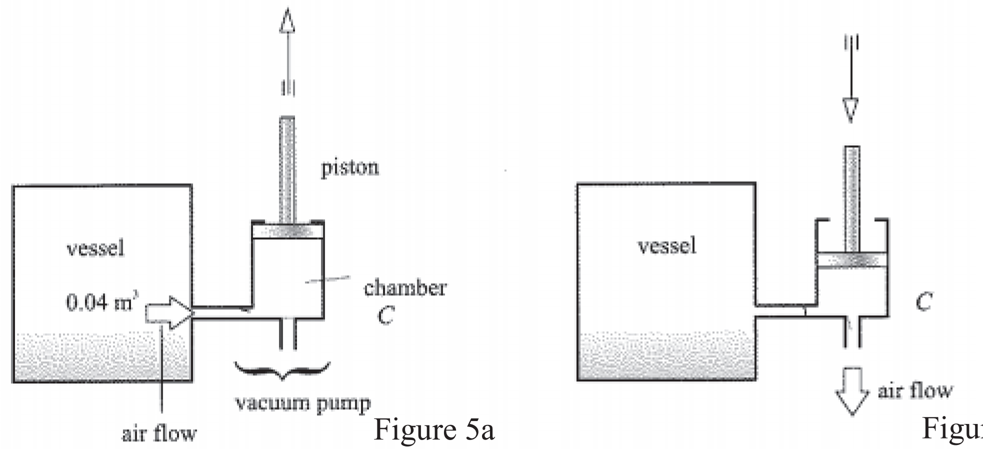


Figure 5a Figure 5b

(a) Give TWO assumptions about ideal gas. (2 marks)

(b) If the initial pressure in the vessel is 100 kPa, calculate the pressure in the vessel after one up and down movement of the piston. (3 marks)

(c) What is the final pressure of the vessel after 10 cycles of the piston movement? (2 marks)

6. Two vessels, *A* and *B*, of equal volume 0.02 m^3 are connected by a small tube with a tap as shown in Figure 6. Initially, the tap is closed and the two vessels *A* and *B* contain ideal gases at pressures 100 kPa and 150 kPa respectively. The temperatures of *A* and *B* are 290 K and 320 K respectively.

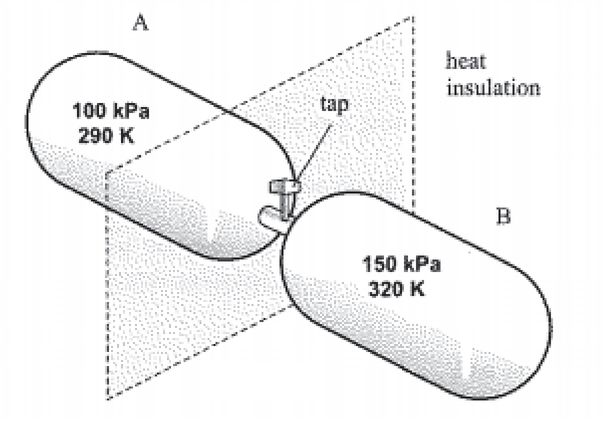


Figure 6

(a) Find the number of moles of gas in each vessel. (3 marks)

(b) When the tap is opened, the gases can flow between the vessels. Assume that the gases do not react chemically. If the temperature of each vessel remains unchanged, what will be the final pressure inside the vessels? (3 marks)

7. Figure 7 below shows the displacement-time graph of boy running along a straight path.

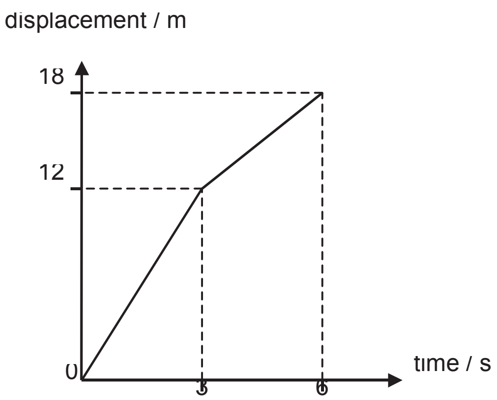


Figure 7

(a) Sketch the velocity–time graph of the boy. (3 marks)

(b) What is the average velocity of the boy for the whole journey? (2 marks)

8. A car is travelling at a speed of 15 m s^{-1} on a straight road.

(a) The driver sees a potential danger ahead and applies the brake to stop the car. If the reaction time of the driver is 0.6 s and that the car decelerates at 4 m s^{-2}, how far would the car travel before coming to stop? (3 marks)

(b) Sketch the velocity-time graph of the car. (2 marks)

(c) Now suppose the driver sees a traffic light turning from green to yellow when the car is at a distance of 33 m from a road intersection as shown in Figure 8. It is known that the traffic light will turn red 3 s later.

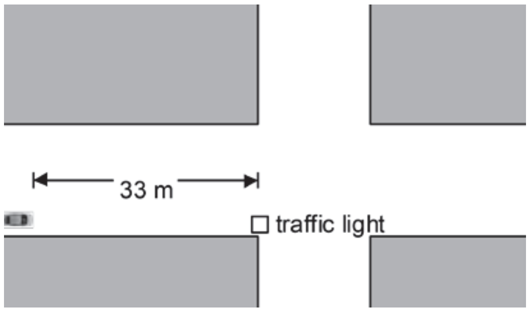


Figure 8

(i) If the driver decides to keep the velocity of the car constant, how far does the car travel for 3 s? (1 mark)

(ii) Based on the results above, do you think that the driver should brake the car, or pass the traffic light at a constant velocity? Give a reason. (2 marks)

9. Peter throws a ball vertically upwards with an initial speed of 20 m s^{-1}.

(a) Find

(i) the time taken for the object to return to its starting position, and (2 marks)

(ii) the maximum height attained. (2 marks)

(b) Peter claims that the acceleration-time graph of the ball should look like Figure 9 as shown below. Comment on this view. (2 marks)

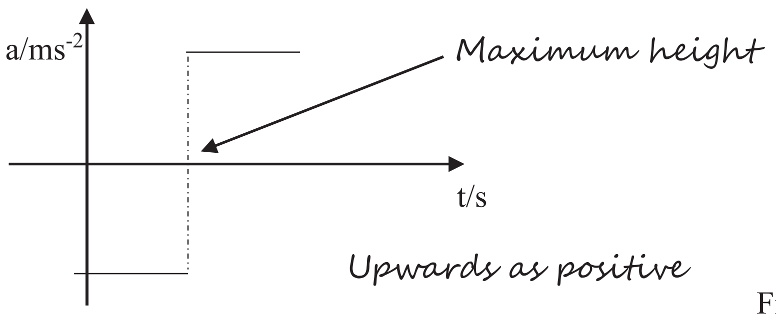


Figure 9

End of Section B

End of Paper