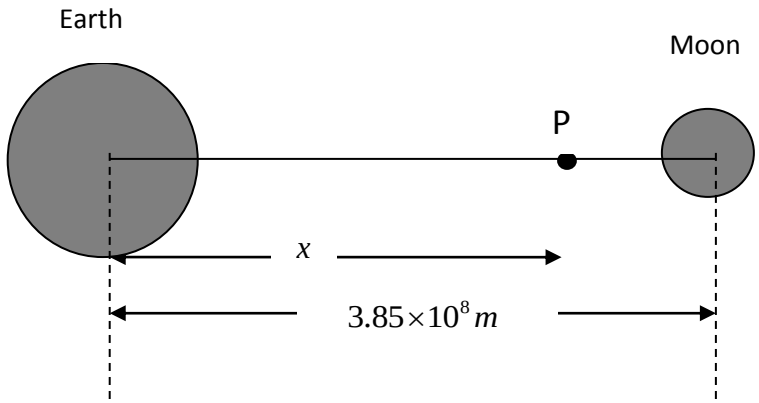
Section B [15 marks]

Answer all questions in this section in the space provided.

16. At position P on the line joining the centers of the Earth and the Moon as shown in the diagram below, the gravitational field strength is equal to zero.



If the distance between the Earth and the Moon is $3.85\text{x}10^8$ m and the mass of the Moon is equal to $7.40\text{x}10^{22}$ kg,

(a) determine the distance x of the point P from the center of the Earth. [3]

$g_m = g_E$ 1

$g = \frac{GM}{r^2}$ 1

$\frac{GM_E}{x^2} = \frac{GM_m}{(d-x)^2}$

$\frac{5.97\times10^{24}}{x^2} = \frac{7.4\times10^{22}}{(3.85\times10^8 - x)^2}$

$x = 3.464\times10^8 m / 3.46\times10^8 m$ 1

(b) calculate the escape velocity from the point P. [3]

$V = -\frac{GM}{r}$ 1

$V_P = -\frac{GM_E}{x} - \frac{GM_m}{d-x}$

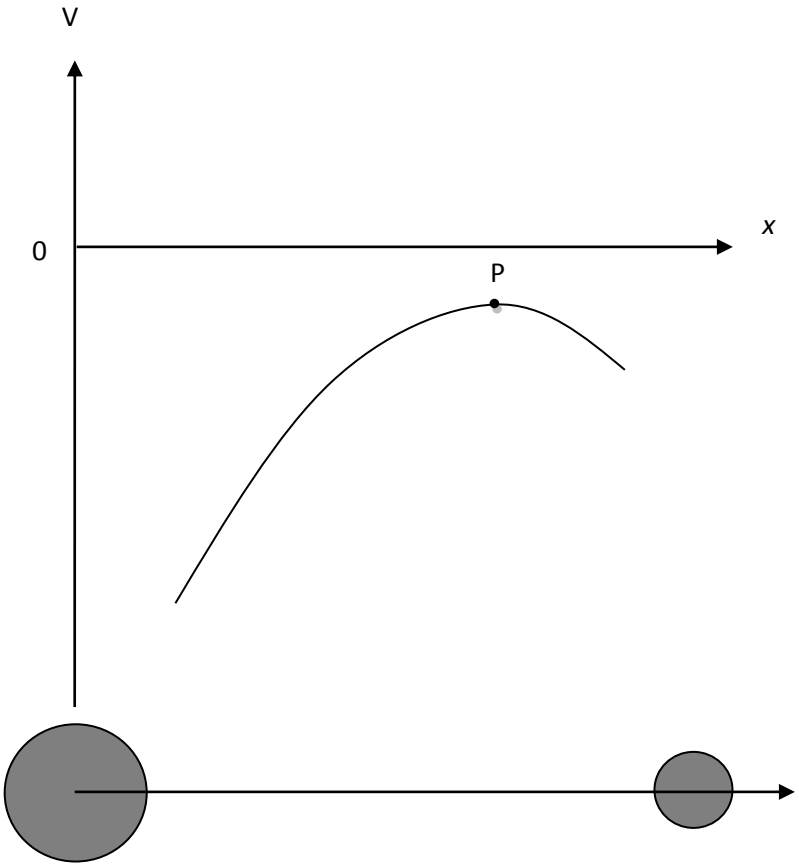
$= -1.277\times10^6\, Jkg^{-1}$

$\frac{1}{2}mv^2 = 0 - mV_p$ 1

$v = \sqrt{2\times1.277\times10^6}$

$= 1598 m/s \;\; or \;\; 1600 m/s$ 1

(c) On the axes below, sketch a graph to show the variation of gravitational potential V with the distance *x* between the surface of the Earth and the Moon. [2]



17. A block of mass 2.00 kg is released from rest at distance 80.0 cm above a vertical spring and the spring is then compressed by 20.0 cm before the block momentarily comes to rest as shown in the diagram below.

(a) State the transformation of energy in the process above. [2]

Before reaching the spring :

Gravitational potential energy → Kinetic energy. *1*

After collision with the spring:

Gravitational Potential energy + kinetic energy → Elastic Potential energy. *1*

(b) Calculate the force constant of the spring. [4]

$Elastic\ PE = ½\ K\ e^2$	1
$Mgh = ½\ K\ e^2$	1
$Mg\ (h_o+e) = ½\ K\ e^2$	1
$2x9.81(1) = ½\ K\ (0.2)^2$	
$K = 981\ N\ m^{-1}$	1

(c) Two identical springs are then arranged in parallel and the same block is released from the same height as shown in the diagram below.

Calculate the maximum compression of the spring system. [2]

$Total\ energy\ stored\ in\ the\ spring = ½\ K\ e^2 + ½\ K\ e^2$	1
$Mg(h_o+e) = K\ e^2$	
$2x9.81(0.8+e) = 981xe^2$	
$e = 13.69\ cm$ or $13.7\ cm.$	1

Or

$K' = K_1 + K_2 = 2K$	1
$Mg(h_o+e) = ½\ K'\ e^2$	
$2x9.81(0.8+e) = ½ \times 2x981xe^2$	
$e = 13.69\ cm$ or $13.7\ cm.$	1

Section C: Answer **any two questions** only from this section.

18. (a) Define the coefficient of static friction. [1]

Coefficient of static friction is the ratio of the maximum static friction to the normal reaction.

Or $\mu_s = \frac{f_s}{R}$ f_s = *Maximum static friction*

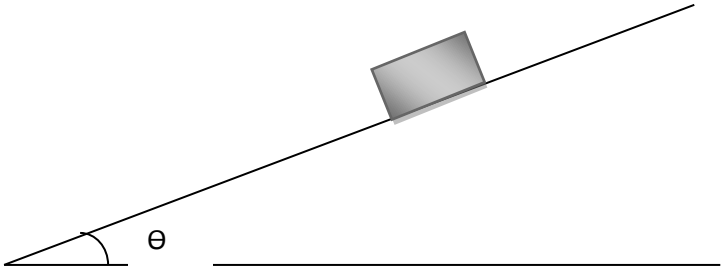
R= normal reaction

(b) State two differences between static friction and kinetic friction. [2]

Any two below:

1. *Static friction is variable but kinetic friction is constant.*
2. *The maximum static friction is greater than kinetic friction.*
3. *Static friction acts on two solid surfaces when there is no relative motion between the surfaces but kinetic friction acts on two solid surfaces sliding on each other.*

(c) A wooden block is placed on an inclined plane with coefficient of static friction 0.500 and coefficient of kinetic friction 0.300 as shown in the diagram below. If the angle of inclination Θ is increased gradually from zero, find the maximum angle that the block will remain stationary on the slope. [4]



$f_s = \mu_s R$	1
$R = mg\cos\theta$	1
$f_s = mg\sin\theta$	1
$\mu_s mg\cos\theta = mg\sin\theta$	
$\tan\theta = \mu_s$	
$\tan\theta = 0.500$	
$\theta = 26.6^o$	1

(d) The inclined plane in part (c) is now set at angle of inclination of 45.0^0. If the block is released from rest, calculate the acceleration of the block sliding down the slope. [3]

$F_R = mg\sin\theta - f_k$

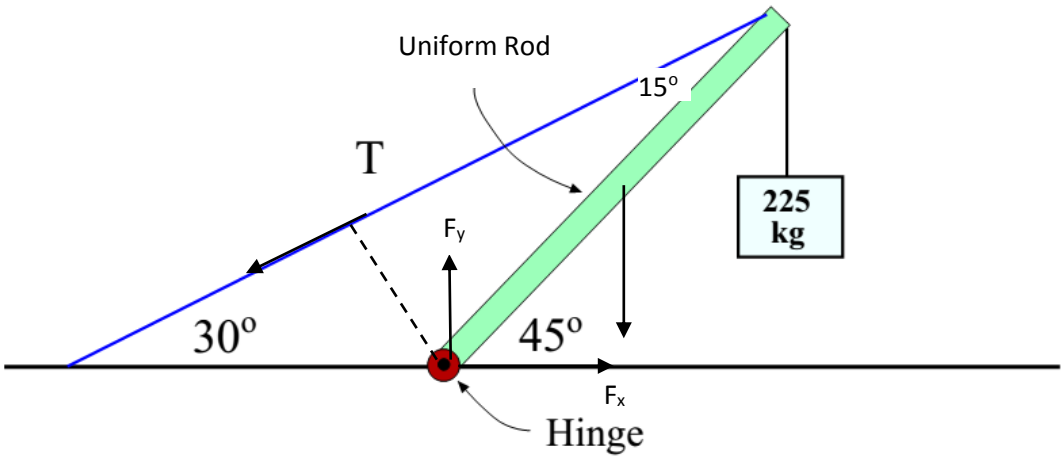
$F_R = ma$

$ma = mg\sin 45^o - 0.300 \times mg\cos 45^o$

$a = 4.856 ms^{-2}$ *or* $4.86 ms^{-2}$

1
1
1

(e) A mass of 225 kg hangs from one end of a uniform rod with another end hinged on the floor as shown in the diagram below. The system is maintained in static equilibrium by a cable attached to the upper end of the rod.



If the mass of the rod is 45.0 kg and the inclination angles of the rod and the cable are 45.0^0 and 30.0^o respectively, determine

(i) the tension in the cable. [2]

Consider torque about the hinge:

$$mg \times \frac{L}{2}\cos 45^o + Mg \times L\cos 45^o = T \times L\sin 15^o$$

$$45 \times 9.81 \times \frac{L}{2}\cos 45^o + 225 \times 9.81 \times L\cos 45^o = TL\sin 15^o$$

$$T = 6633N \quad or \quad 6630N$$

1
1

(ii) the magnitude of the reaction force acting on the lower end of the rod by the hinge. [3]

$F_x = T\cos 30^o$
$= 5744N$
$F_y = (M+m)\,g + T\sin 30^o$
$= 5965N$
$F = \sqrt{F_X^2 + F_Y^2}$
$= 8281N \text{ or } 8280N$

1
1
1

19. (a) Define Newton's Laws of Motion. [3]

Newton's first law states that an object will remain stationary or moving in a straight line with constant speed if no external force acting on it.

Newton's second law states that the rate of change of momentum is directly proportional to the resultant force and acts in the direction of the force.

Newton's third law states that action and reaction are equal in magnitude but act in opposite direction.

(b) Sand from a stationary hopper falls onto a moving conveyor belt at the rate of 5.0 kg/s. The conveyer belt is supported by frictionless rollers. It moves at a constant speed of 0.75 m/s under the action of a constant horizontal external force F_{ext} supplied by the motor that drives the belt as shown in the diagram below.

(i) Explain the motion of the sand after it has fallen on the conveyor belt. [3]

Initiall the sand will be sliding on the conveyor belt. *1*

The friction acting on the sand is used to accelerate the sand. *1*

When the sand has achieved the same speed as the conveyor belt, no sliding occurs and friction decreases to zero. *1*

(ii) Explain why the motor needs to supply an external force to drive the belt although it is moving at constant speed. [2]

There is a friction force between the sand and the belt. *1*

Therefore the motor needs to supply an external force to overcome the friction. *1*

(iii) Determine the magnitude of the external force F_{ext} [2]

$F_{ext} = \frac{dm}{dt}v$
$= 5 \times 0.75$
$= 3.75N$

1
1

(iv) Determine the power supplied by the motor. [2]

$$P = Fv$$
$$= 3.75 \times 0.75$$
$$= 2.81W$$

1

1

(v) calculate the kinetic energy acquired by the falling sand each second due to the change in its horizontal motion. [2]

$$\frac{dE}{dt} = \frac{\frac{1}{2}mv^2}{t} = \frac{1}{2}\frac{dm}{dt}v^2$$
$$= \frac{1}{2} \times 5 \times 0.75^2$$
$$= 1.41Js^{-1}$$

1

1

(vi) Explain the difference in the answers (iv) ad (v) above. [1]

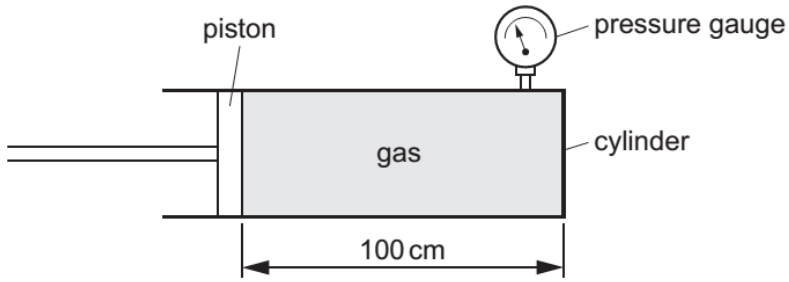
Only half of the work done is changed into kinetic energy, another half of the work done is changed into heat / work done against friction.

20. (a) State two differences between an ideal gas and a real gas in term of molecules. [2]

1. In ideal gas, the intermolecular force is negligible but in real gas, intermolecular force is not negligible.

2. The volume of the molecules of ideal gas is negligible but volume of molecules in real gas is not negligible.

(b) The diagram below shows 10.0 moles of oxygen gas (O_2) contained in a cylinder enclosed by a piston. At first, the length of cylinder containing the gas is 100 cm. The pressure of the gas, shown by the pressure gauge, is 300 kPa. The area of cross-section of the cylinder is 0.120 m^2.



(i) Explain how the molecules exert a force on the walls of the cylinder. [2]

When the molecules collide on the wall, the molecules will rebound with the same speed and there is a change in momentum of the molecules. *1*

The force acting on the wall is equal to the rate of change of momentum. *1*

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- Semester 1: kertas percubaan (trial) negeri, subjek yang dipilih + skema
- Blueprint 30 hari Semester 1 (setiap subjek)
- Semester 3: percubaan 2024, 10 subjek, banyak negeri, soalan + skema dalam satu fail

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