FUKIEN SECONDARY SCHOOL

S4 Final Examination (2020-2021)

Physics

(1 hour 30 minutes)

Date: 17th June 2021 Name: _____

Time: 8:30 a.m. – 10:00 a.m. 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

Acceleration due to gravity $g = 9.81\ \text{m s}^{-2}$ (close to the Earth surface)

Universal gravitational constant $G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$

Formula

For uniformly accelerated motion:

$$v = u + at$$

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

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

Equation of a straight line $y = mx + c$

Arc length $= r\theta$

B1. $F = m\frac{\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$ force

B2 moment $= F \times d$ moment of a force

B3. $E_P = mgh$ gravitational potential energy

B4. $E_K = \frac{1}{2}mv^2$ kinetic energy

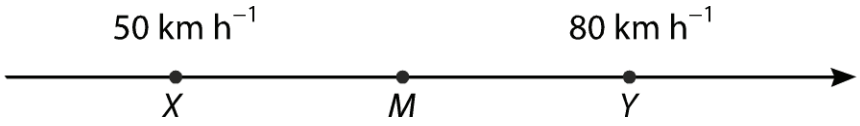
B5. $P = Fv = \frac{W}{t}$ mechanical power

B6. $a = \frac{v^2}{r} = \omega^2 r$ centripetal acceleration

B7. $F = \frac{Gm_1m_2}{r^2}$ Newton's law of gravitation

Section A: Multiple Choice Questions (30 marks)

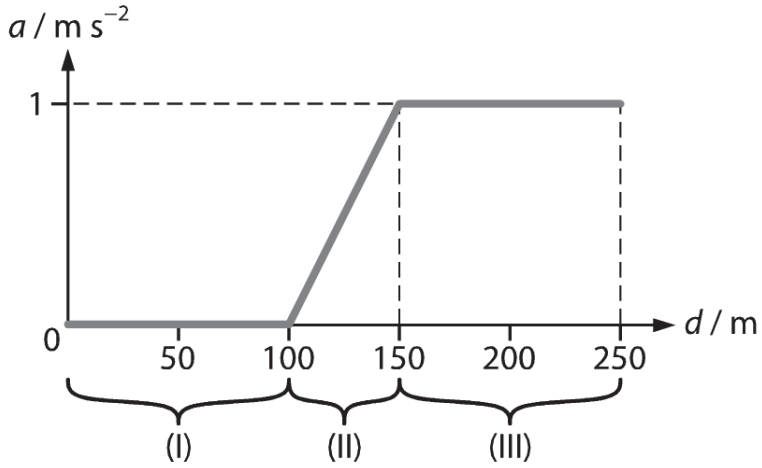
1. A car accelerates uniformly along a straight line. It passes the first point *X* with speed 50 km h^{-1} and the second point *Y* with speed 80 km h^{-1}.



What is its speed when the car passes *M*, the mid-point of *X* and *Y*?

A. 63.2 km h^{-1}
B. 64.3 km h^{-1}
C. 65.0 km h^{-1}
D. 66.7 km h^{-1}

2. A car moves along a straight road and passes a traffic light. The following graph shows how the acceleration *a* of the car changes with the distance *d* of the car away from the traffic light. The motion of the car can be divided into three stages (I), (II) and (III). When the distance *d* of the car away from the traffic light is 150 m, its speed is 10 m s^{-1}.

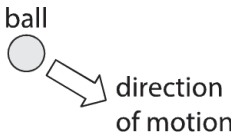


Which of the following statements about the motion of the car is/are correct?

(1) The car travels at a non-zero constant speed in stages (I) and (III).
(2) The car accelerates uniformly in stage (II).
(3) The speed of the car is 17.3 m s^{-1} when it is 250 m away from the traffic light.

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

3. The following figure shows a ball flying in air at a certain moment. The arrow in the figure shows the direction of motion of the ball at that moment.



Side view

If air resistance CANNOT be neglected, which free-body diagram below best shows all the forces acting on the ball at that moment?

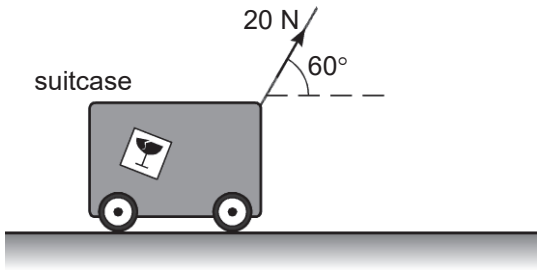
A.

B.

C.

D.

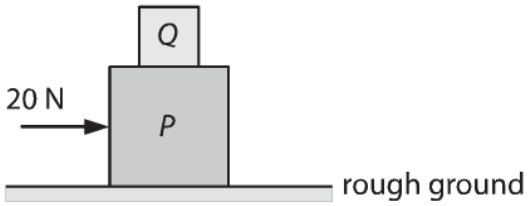
4. A force of magnitude 20 N is applied to a suitcase of weight 40 N at an angle of 60° to the horizontal as shown below.



Suppose the suitcase moves on the horizontal ground at a constant velocity. What is the magnitude of the resultant acting on the suitcase by the ground?

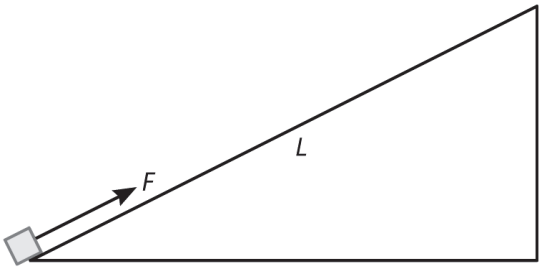
A. 17.3 N
B. 22.7 N
C. 24.8 N
D. 30.0 N

5. As shown below, block P of weight 4 N is placed on a rough horizontal ground. Block Q of weight 1 N is placed on the top of P. A force of 20 N is applied on P to the right so that both blocks accelerate without slipping. If the friction acting on P by the ground is 0.6 times the normal reaction acting on P by the ground, what is the friction acting on Q by P?



A. 3.52 N to the left
B. 3.52 N to the right
C. 3.40 N to the left
D. 3.40 N to the right

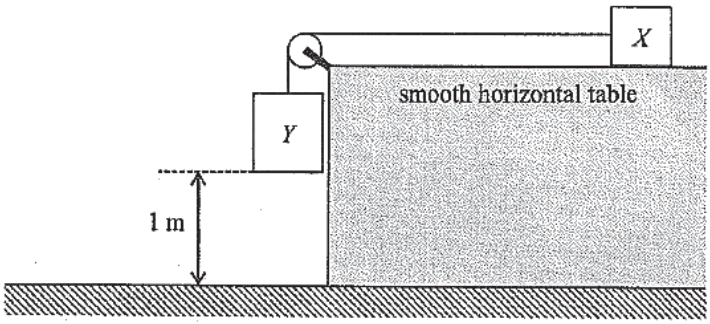
6. A block is pulled up a rough slope by a constant force F from rest. The length of the slope is L. When the block reaches the mid-point of the slope, the force is withdrawn. The block continues to move up and it can just reach the top of the slope.



Find the total work done by the force F and the kinetic energy of the block when the block reaches the mid-point of the slope.

	Work done	Kinetic energy
A.	$\frac{FL}{2}$	$\frac{FL}{4}$
B.	$\frac{FL}{2}$	$\frac{FL}{8}$
C.	FL	$\frac{FL}{4}$
D.	FL	$\frac{FL}{8}$

7. Blocks X and Y are connected by a light inextensible string passing over a fixed frictionless light pulley as shown below. The mass of X and Y are 0.5 kg and 1 kg respectively. Initially, Y is 1 m above the ground and the string is taut. The system is then released from rest. What is the speed of Y just before it reaches the ground?



A. 3.62 ms^{-1}
B. 4.43 ms^{-1}
C. 6.26 ms^{-1}
D. 9.81 ms^{-1}

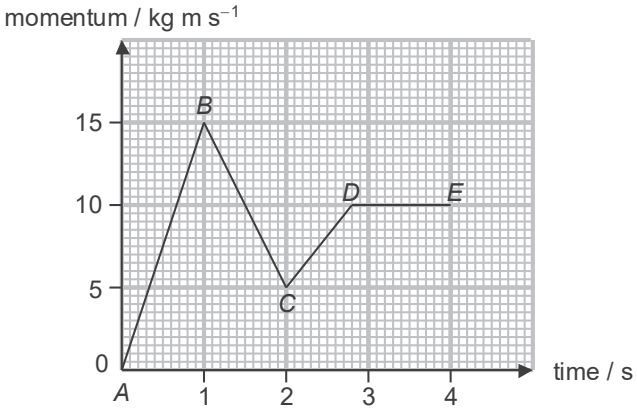
8. Two identical balls P and Q are placed on a smooth track as shown below. The track consists of a curved segment AB of height h and a horizontal segment BC. Initially, P and Q are held at rest at A and B respectively.

When P is released, it moves down the track and collides with Q. The two balls move together towards C at a common speed after collision. Which of the following statements are correct?

(1) The total momentum of the balls conserves during the collision.
(2) The total kinetic energy of the balls conserves during the collision.
(3) The common speed of the two balls is $\sqrt{gh}$.

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

9. The graph below shows how the momentum of an object changes with time.



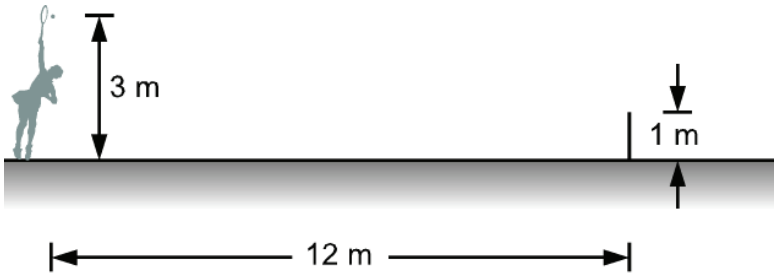
In which time interval is the net force acting on the object the greatest?

A. *BC*
B. *DE*
C. *CD*
D. *AB*

10. What is the maximum range that can be reached by an object which is projected at a speed of 100 m s^{-1} from the ground?

A. 102 m
B. 509 m
C. 1019 m
D. 5097 m

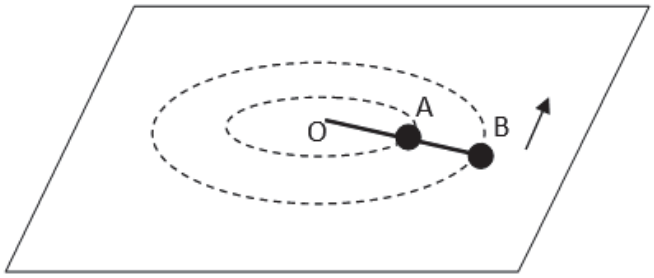
11. Amy hits a tennis ball, which is initially at rest, at a height of 3 m above the ground. The ball flies off in the horizontal direction and just passes the net which is 12 m away from the player.



What is the time required for the ball to travel from Amy to the net?

A. 0.4 s
B. 0.6 s
C. 0.639 s
D. 0.775 s

12. In the figure below, A and B are two identical balls. They are fixed on a rod and rotating with it. The distances of the balls A and B from centre O are R_1 and R_2 respectively. What is the ratio of the angular speed of A to that of B?



A. 1 : 1
B. 2 : 1
C. $R_2 : R_1$
D. $R_1 : R_2$

13. An object is in uniform circular motion. Which of its quantities will increase if both its mass and the radius of the path are doubled while its speed remains unchanged?
(1) centripetal acceleration
(2) centripetal force
(3) angular speed
A. (1) only
B. (2) only
C. (3) only
D. None of the above

14. Which of the following statements about g, the gravitational field strength near the Earth's surface, is correct?
A. g is independent of the Earth's mass.
B. g is independent of the mass of the objects on the Earth.
C. g is related to both the Earth's mass and the mass of the objects on the Earth.
D. g is only related to the mass of the objects on the Earth.

15. The gravitational field strength at a distance d from the Earth's surface is 8.8 N kg^{-1}. What is the gravitational field strength at a distance $2d$ from the Earth's surface? Assume the effect of the Sun and other planets is negligible. The radius of the Earth is 6370 km.
    A. 5.77 N kg^{-1}
    B. 7.79 N kg^{-1}
    C. 7.94 N kg^{-1}
    D. 17.6 N kg^{-1}

End of Section A

Section B: Structured Questions (60 marks)

1. Figure 1.1 below shows a conveyor belt in a factory. A parcel of mass 10 kg is placed at position P when the belt remains at rest. The worker controls the belt to move the parcel.

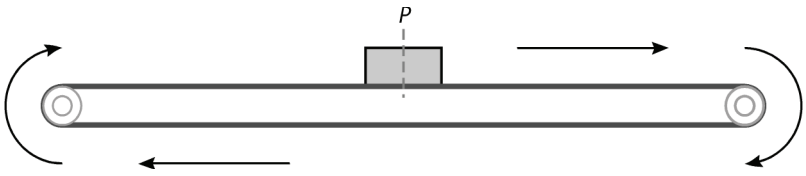


Figure 1.1

The variation of the velocity of the parcel over time is shown in Figure 1.2. The direction to the right is taken as positive.

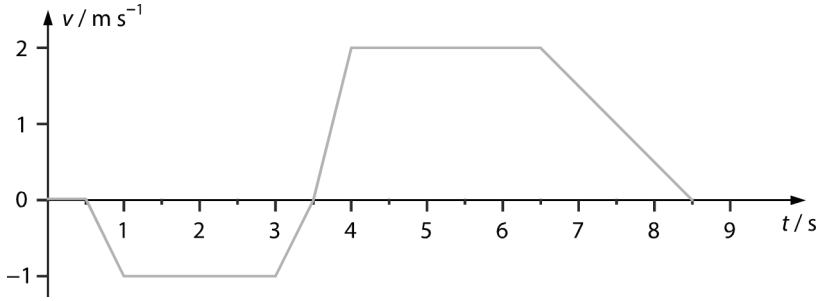


Figure 1.2

(a) Describe the motion of the parcel from $t = 0.5$ s to $t = 3$ s. (2 marks)

(b) When does the parcel pass through position P again? Explain your answer. (3 marks)

(c) The parcel and the conveyor belt move together without slipping during the entire motion.

(i) In which period does the parcel experience the greatest frictional force by the conveyor belt throughout the entire motion? Find this force. (3 marks)

(ii) Sketch the variation of the acceleration of the parcel over time. (3 marks)

2. As shown in Figure 2, two blocks X and Y of masses 4 kg and 3 kg respectively are connected by an inextensible light string. A constant force of 25 N is applied on Y to pull the blocks up an inclined plane at a constant speed of 3.5 m s^{-1} as shown below. The plane makes an angle θ with the horizontal. The frictional force between **each block** and the inclined plane is 2 N.

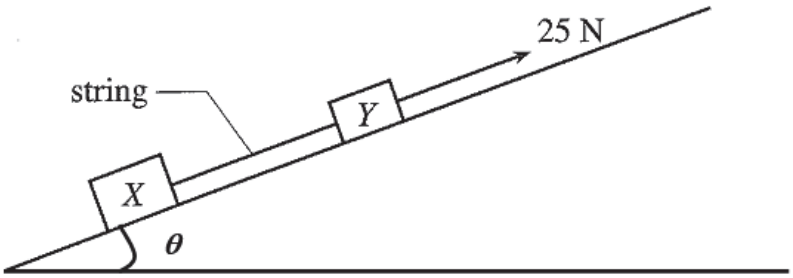


Figure 2

(a) Find the angle θ. (3 marks)

(b) Suddenly the string breaks at $t = 4$ s. Describe the subsequent motion of block X after $t = 4$ s. Calculate the corresponding accelerations. (6 marks)

3. (a) As shown in Figure 3.1, an archer is preparing to shoot an arrow. If his right hand is exerting a force of 136 N on the bowstring, and that the bowstring on each side makes an angle of 65° with the arrow, find the tension T in the bowstring. (3 marks)

(b) As shown in Figure 3.2, two blocks of masses of 4 kg and 6 kg are connected by a light inextensible string passing over a light and smooth pulley. When the blocks are released, find the acceleration of the two masses and the tension in the string. (4 marks)

(c) As shown in Figure 3.3, two uniform objects of length L are stacked near the edge of a table. Find the maximum distance d so that the two objects do not fall over. (Hint: find the maximum value of distance x first.) (4 marks)

Figure 3.1

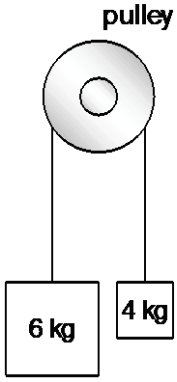


Figure 3.2

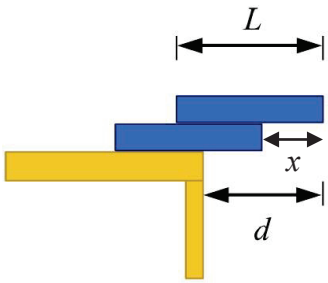


Figure 3.3

4. A ball A collides head-on with another stationary ball B on a horizontal platform. Before the collision, ball A travels at a velocity of 5 m s^{-1}. After the collision, ball B accelerates to 6 m s^{-1}. It is known that ball A and ball B have masses of m_A = 0.4 kg and m_B = 0.2 kg respectively.

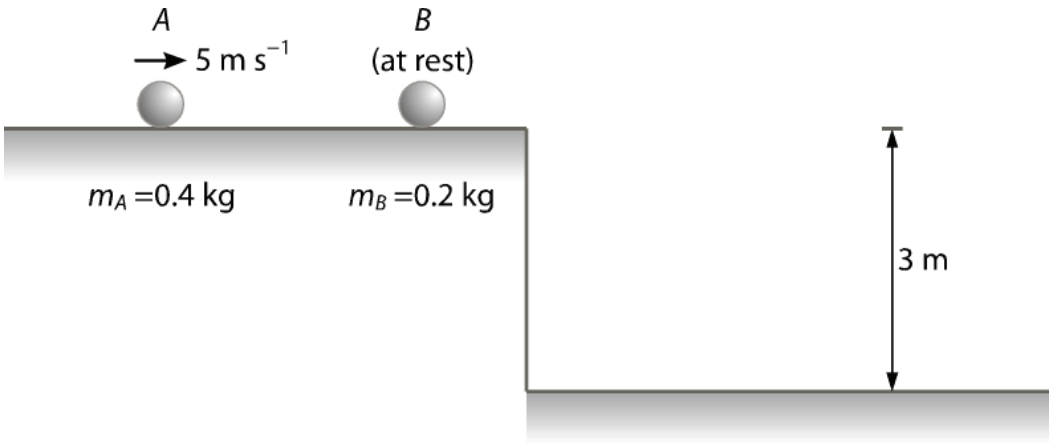


Figure 4

(a) What is the velocity of ball A after the collision? (2 marks)

(b) Is the collision elastic? Explain your answer briefly. (2 marks)

(c) Ball B then flies off the edge of the platform and lands on a ground 3 m below.

(i) Find the horizontal distance between the landing position and the edge of the platform. (3 marks)

(ii) Find the landing speed of ball B. (3 marks)

(d) If two balls stick together after collision, what will be the change of the answer in (c)(i)? Explain your answer briefly. (2 marks)

5. Figure 5 shows a runway with a circular loop. It consists of a smooth track *ABCD* and a rough horizontal track *DE* of length 12 m. Take the potential energy at *D* as zero. A small ball of mass 0.4 kg is released from rest at *A*. The speed of the ball at *D* is 15 m s^{-1}.

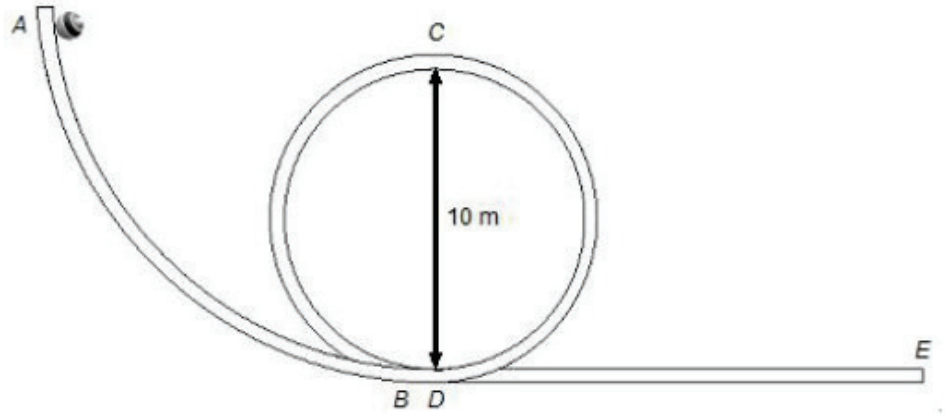


Figure 5

(a) Describe the energy change of the object as it moves along *ABCDE*. (3 marks)

(b) Find the gravitational potential energy and the speed of the object at *C*. (4 marks)

(c) Suppose the average frictional force acting on the object along *DE* is 4 N. Determine whether the object can reach *E*. (2 marks)

6. A toy aeroplane of mass 0.5 kg flies in a horizontal circle. The lifting force $U = 10$ N is perpendicular to the wings. The aeroplane completes one revolution in 6 s.

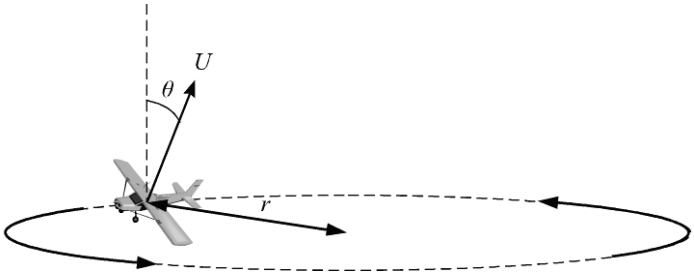


Figure 6

(a) Find the angular speed of the aeroplane. (2 marks)

(b) Find θ, the angle between the vertical and the lifting force. (2 marks)

(c) Find the radius of the circle *r*. (2 marks)

(d) The lifting force *U* remains unchanged. If the mass of the aeroplane becomes smaller, how does θ change? Explain your answer briefly. (2 marks)

End of Section B
End of Paper