

1. If a moving object is subject to a constant force, which of the following can be correctly deduced from Newton's first law?

- A. The object continues to move with a changing velocity.
- B. The object continues to move with a constant velocity.
- C. The object continues to move with a changing direction.
- D. The object continues to move in the same direction.

(Total 1 mark)

2. Which of the following is equivalent to the principle of energy conservation?

- A. Newton's first law
- B. The first law of thermodynamics
- C. Newton's second law
- D. The second law of thermodynamics

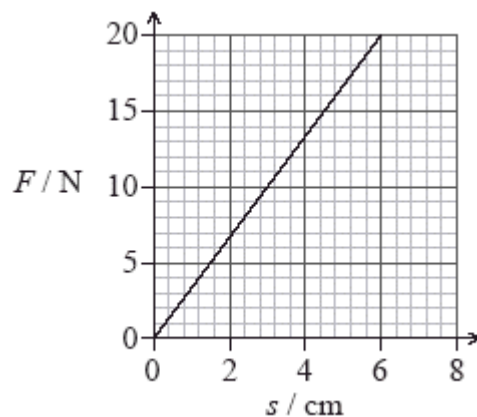
(Total 1 mark)

3. Which of the following is the condition for a body to be in translational equilibrium?

- A. The resultant force on the body in any direction is zero.
- B. The velocity of the body in any direction is zero.
- C. No external force is acting on the body.
- D. No work is done on the body.

(Total 1 mark)

4. The graph shows the variation with force F of the extension s of a spring.



The work done in changing the extension of the spring from 3.0 cm to 6.0 cm is

- A. 15 N cm.
- B. 30 N cm.
- C. 45 N cm.
- D. 60 N cm.

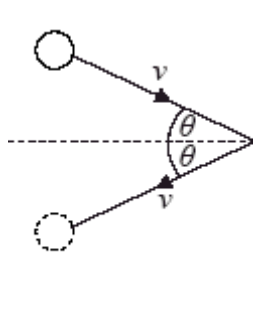
(Total 1 mark)

5. A force F is applied to a body moving along a straight line. A resistive force f acts on the body. Both forces act along the same straight line as the motion of the body. The rate of change of momentum of the body is equal to

- A. $F - f$.
- B. F .
- C. $F + f$.
- D. f .

(Total 1 mark)

6. A gas atom strikes a wall with speed v at an angle θ to the normal to the wall. The atom rebounds at the same speed v and angle θ .



Which of the following gives the magnitude of the momentum change of the gas atom?

- A. zero
- B. $2mv \sin \theta$
- C. $2mv$
- D. $2mv \cos \theta$

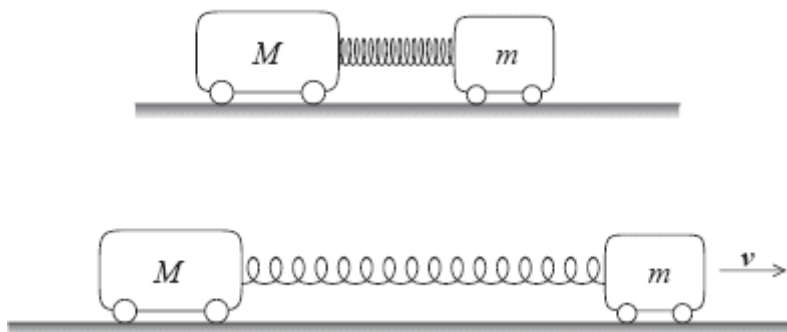
(Total 1 mark)

7. A lift (elevator) is operated by an electric motor. It moves between the 10th floor and the 2nd floor at a constant speed. One main energy transformation during this journey is

- A. gravitational potential energy \rightarrow kinetic energy.
- B. electrical energy \rightarrow kinetic energy.
- C. kinetic energy \rightarrow thermal energy.
- D. electrical energy \rightarrow thermal energy.

(Total 1 mark)

8. Two carts of different mass m and M are connected by a spring. They are pushed together such that the spring is compressed.



After the carts are released, the cart of mass m moves with velocity v . The change in the momentum of mass M is

- A. mv .
- B. $-mv$.
- C. Mv .
- D. $-Mv$.

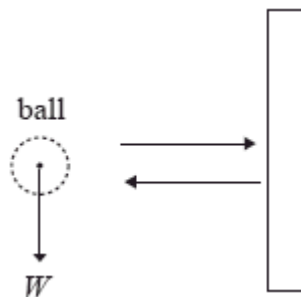
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9. Which of the following is a correct statement of Newton's second law of motion?

- A. A force acting on a body is proportional to the mass of the body.
- B. The rate of change of momentum of a body is equal to the net external force acting on the body.
- C. The momentum of a body is proportional to the net external force acting on the body.
- D. A force acting on a body is proportional to the acceleration of the body.

(Total 1 mark)

10. A ball of weight W is travelling horizontally towards a vertical wall. It strikes the wall and rebounds horizontally. The change in the magnitude of the momentum of the ball is Δp . Which of the following is the magnitude of the impulse that the ball imparts to the wall?



- A. $W + \Delta p$
- B. $W - \Delta p$
- C. W
- D. Δp

(Total 1 mark)

11. A constant force of magnitude F is applied to a mass m for a time interval Δt . The magnitude of the impulse given to the mass equals

- A. $\frac{F}{m}$.
- B. $\frac{F}{\Delta t}$.
- C. $F\Delta t$.
- D. $\frac{F\Delta t}{m}$.

(Total 1 mark)

12. A railway engine of mass m moves along a horizontal track with uniform speed v . The total resistive force acting on the engine is F .



Which of the following is the power of the engine?

- A. $\frac{F}{mv}$
- B. Fv
- C. $\frac{mv}{F}$
- D. $\frac{v}{F}$

(Total 1 mark)

13. A communications satellite is moving at a constant speed in a circular orbit around Earth. At any given instant in time, the resultant force on the satellite is
- A. zero.
 - B. equal to the gravitational force on the satellite.
 - C. equal to the vector sum of the gravitational force on the satellite and the centripetal force.
 - D. equal to the force exerted by the satellite's rockets.

(Total 1 mark)

14. The diagram shows a girl attempting (but failing) to lift a heavy suitcase of weight W . The magnitude of the vertical upwards pull of the girl on the suitcase is P and the magnitude of the vertical reaction of the floor on the suitcase is R .

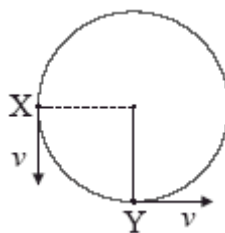


Which equation correctly relates W , P and R ?

- A. $W = P + R$
- B. $W > P + R$
- C. $W < P + R$
- D. $W = P = R$

(Total 1 mark)

15. A stone attached to a string is moving in a horizontal circle. The constant speed of the stone is v . The diagram below shows the stone in two different positions, X and Y.



Which of the following shows the direction of the change of velocity of the stone when moving from position X to position Y?

- A.
- B.
- C.
- D.

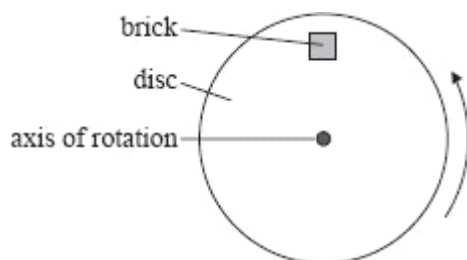
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16. Two objects undergo an inelastic collision. Which of the following is correct in respect of both the conservation of momentum and the conservation of total energy of the system?

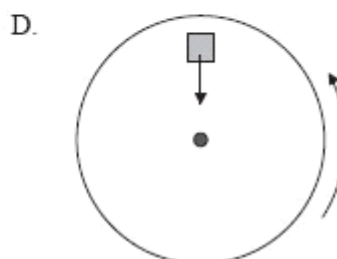
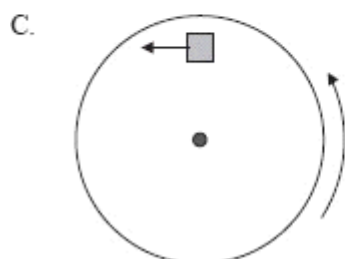
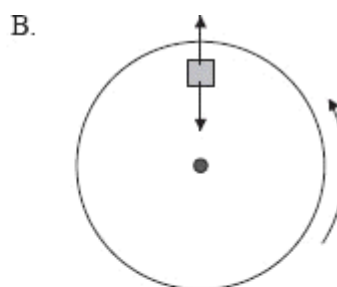
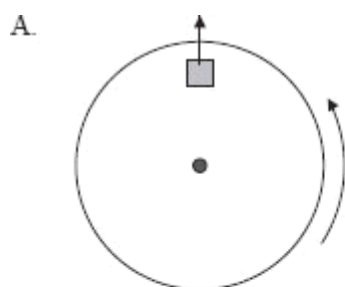
	Momentum	Total energy
A.	conserved	not conserved
B.	conserved	conserved
C.	not conserved	not conserved
D.	not conserved	conserved

(Total 1 mark)

17. A brick is placed on the surface of a flat horizontal disc as shown in the diagram below. The disc is rotating at constant speed about a vertical axis through its centre. The brick does not move relative to the disc.



Which of the diagrams below correctly represents the **horizontal** force or forces acting on the brick?



(Total 1 mark)

18. Which of the following quantities can be determined from a speed-time graph of a particle travelling in a straight line?

- A. Only the magnitude of the acceleration at a given instant
- B. Both the velocity and the acceleration at a given instant
- C. Only the distance travelled in a given time
- D. Both the distance travelled in a given time and the magnitude of the acceleration at a given instant

(Total 1 mark)

19. Which of the following is a correct definition of work?

- A. Product of force and distance
- B. Product of force and distance moved in the direction of the force
- C. Product of power and time
- D. Product of force and displacement

(Total 1 mark)

20. Stephen pushes two boxes P and Q, that stay in contact, along a rough table, with a force F of 30 N.
Box P has a mass of 2.0 kg and box Q has a mass of 4.0 kg. Both boxes move with constant speed.



The resultant force on box Q is

- A. 0 N.
- B. 5.0 N.
- C. 15 N.
- D. 30 N.

(Total 1 mark)

21. This question is about force and energies.

- (a) A system consists of a bicycle and cyclist travelling at a constant velocity along a horizontal road.



- (i) State the value of the net force acting on the cyclist.

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(1)

- (ii) On the diagram draw labelled arrows to represent the vertical forces acting on the bicycle.

(2)

- (iii) With reference to the horizontal forces acting on the system, explain why the system is travelling at constant velocity.

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(2)

- (b) The total resistive force acting on the system is 40 N and its speed is 8.0 m s^{-1} . Calculate the useful power output of the cyclist.

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(1)

- (c) The cyclist stops pedalling and the system comes to rest. The total mass of the system is 70 kg.

- (i) Calculate the magnitude of the initial acceleration of the system.

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(2)

- (ii) Estimate the distance taken by the system to come to rest from the time the cyclist stops pedalling.

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(2)

- (iii) State and explain **one** reason why your answer to (c)(ii) is only an estimate.

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(2)

(Total 12 marks)

22. This question is about momentum, energy and power.

- (a) In his *Principia Mathematica* Newton expressed his third law of motion as “to every action there is always opposed an equal reaction”. State what Newton meant by this law.

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(1)

- (b) A book is released from rest and falls towards the surface of Earth. Discuss how the conservation of momentum applies to the Earth-book system.

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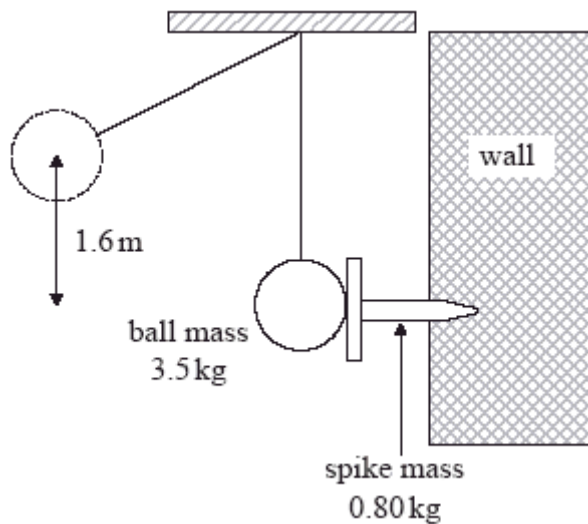
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(3)

- (c) A large swinging ball is used to drive a horizontal iron spike into a vertical wall. The centre of the ball falls through a vertical height of 1.6 m before striking the spike in the position shown. Length of the wire is 3.0 m. Length of the wire is 3.0 m.



The mass of the ball is 3.5 kg and the mass of the spike is 0.80 kg. Immediately after striking the spike, the ball and spike move together. Show that the

- (i) speed of the ball on striking the spike is 5.6 m s^{-1} .

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(1)

- (ii) energy dissipated as a result of the collision is about 10 J.

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(4)

- (d) As a result of the ball striking the spike, the spike is driven a distance 7.3×10^{-2} m into the wall. Calculate, assuming it to be constant, the friction force F between the spike and wall.

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(3)

- (e) The machine that is used to raise the ball has a useful power output of 18 W. Calculate how long it takes for the machine to raise the ball through a height of 1.6 m.

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(3)

- (f) What is the tension on the wire just before the collision.

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(3)

(Total 18 marks)