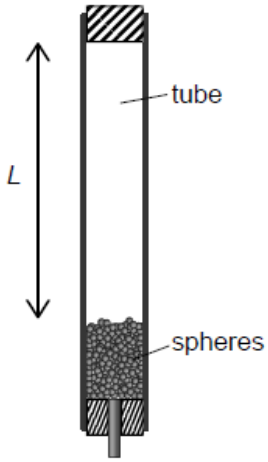
Thermal-practice-1-MC *[60 marks]*

1. Energy is transferred to water in a flask at a rate *P*. The water reaches boiling point and then *P* is increased. What are the changes to the temperature of the water and to the rate of vaporization of the water after the change? *[1 mark]*

	Temperature	Rate of vaporization
A.	increases	unchanged
B.	increases	increases
C.	unchanged	unchanged
D.	unchanged	increases

2. An insulated tube is filled with a large number n of lead spheres, each of mass m. The tube is inverted s times so that the spheres completely fall through an average distance L each time. The temperature of the spheres is measured before and after the inversions and the resultant change in temperature is ΔT. *[1 mark]*

   What is the specific heat capacity of lead?



   A. $\frac{sgL}{nm\Delta T}$

   B. $\frac{sgL}{\Delta T}$

   C. $\frac{sgL}{n\Delta T}$

   D. $\frac{gL}{m\Delta T}$

3. Boiling water is heated in a 2 kW electric kettle. The initial mass of water is 0.4 kg. Assume the specific latent heat of vaporization of water is 2 MJ kg^{-1}. *[1 mark]*

   What is the time taken for all the water to vaporize?

   A. 250 s

   B. 400 s

   C. 2500 s

   D. 4000 s

4. A gas storage tank of fixed volume V contains N molecules of an ideal gas at temperature T. The pressure at kelvin temperature T is 20 MPa. $\frac{N}{4}$ molecules are removed and the temperature changed to $2T$. What is the new pressure of the gas? *[1 mark]*

A. 10 MPa

B. 15 MPa

C. 30 MPa

D. 40 MPa

5. A sky diver is falling at terminal speed when she opens her parachute. What are the direction of her velocity vector and the direction of her acceleration vector before she reaches the new terminal speed? *[1 mark]*

	Direction of velocity vector	Direction of acceleration vector
A.	upwards	upwards
B.	upwards	downwards
C.	downwards	upwards
D.	downwards	downwards

6. A stone is thrown downwards from the edge of a cliff with a speed of 5.0 m s^{-1}. It hits the ground 2.0 s later. What is the height of the cliff? *[1 mark]*

A. 20 m

B. 30 m

C. 40 m

D. 50 m

7. A ball is thrown upwards at an angle to the horizontal. Air resistance is negligible. Which statement about the motion of the ball is correct? *[1 mark]*

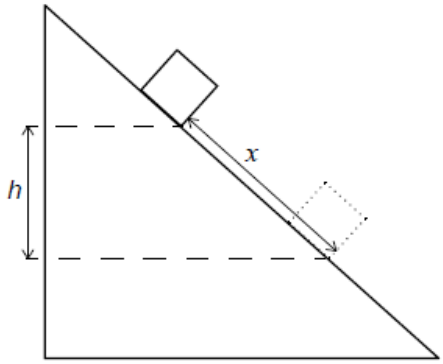
A. The acceleration of the ball changes during its flight.

B. The velocity of the ball changes during its flight.

C. The acceleration of the ball is zero at the highest point.

D. The velocity of the ball is zero at the highest point.

8. An object of mass m is sliding down a ramp at constant speed. During the motion it travels a distance x along the ramp and falls through a vertical distance h. The coefficient of dynamic friction between the ramp and the object is μ. What is the total energy transferred into thermal energy when the object travels distance x? *[1 mark]*



A. mgh

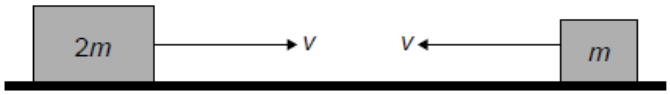
B. mgx

C. μmgh

D. μmgx

9. Two blocks of masses m and $2m$ are travelling directly towards each other. Both are moving at the same constant speed v. The blocks collide and stick together. *[1 mark]*

What is the total momentum of the system before and after the collision?



	Momentum before	Momentum after
A.	mv	mv
B.	mv	$-mv$
C.	$3mv$	$-3mv$
D.	$3mv$	$3mv$

10. The graph shows the variation with time of the resultant net force acting on an object. The object has a mass of 1kg and is initially at rest. *[1 mark]*

What is the velocity of the object at a time of 200 ms?

A. 8 m s^{-1}

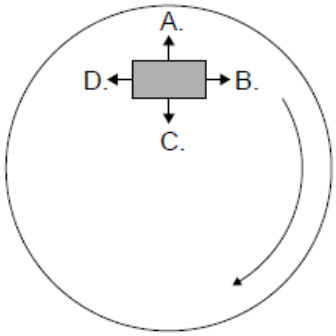
B. 16 m s^{-1}

C. 8 km s^{-1}

D. 16 km s^{-1}

11. A block is on the surface of a horizontal rotating disk. The block is at rest relative to the disk. The disk is rotating at constant angular velocity. *[1 mark]*

What is the correct arrow to represent the direction of the frictional force acting on the block at the instant shown?



12. A substance changes from the solid phase to the gas phase without becoming a liquid and without a change in temperature. *[1 mark]*

What is true about the internal energy of the substance and the total intermolecular potential energy of the substance when this phase change occurs?

	Internal energy of the substance	Total intermolecular potential energy of the substance
A.	increases	no change
B.	no change	no change
C.	increases	increases
D.	no change	increases

13. The temperature of a fixed mass of an ideal gas changes from 200 °C to 400 °C. *[1 mark]*

What is $\frac{\text{mean kinetic energy of gas at 200 }^{\circ}\text{C}}{\text{mean kinetic energy of gas at 400 }^{\circ}\text{C}}$?

A. 0.50

B. 0.70

C. 1.4

D. 2.0

14. A container holds 20 g of argon-40($^{40}_{18}\text{Ar}$) and 40 g of neon-20 ($^{20}_{10}\text{Ne}$) . *[1 mark]*

What is $\frac{\text{number of atoms of argon -40}}{\text{number of atoms of neon -20}}$ in the container?

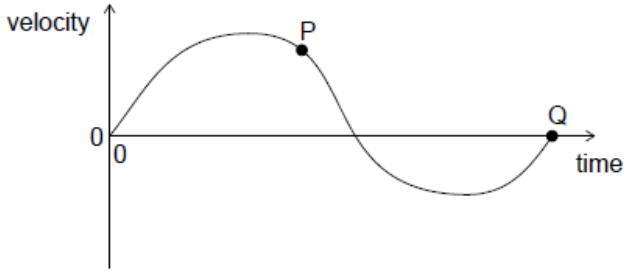
A. 0.25

B. 0.5

C. 2

D. 4

15. The graph shows the variation of velocity of a body with time along a straight line. *[1 mark]*



What is correct for this graph?

A. The maximum acceleration is at P.

B. The average acceleration of the body is given by the area enclosed by the graph and time axis.

C. The maximum displacement is at Q.

D. The total displacement of the body is given by the area enclosed by the graph and time axis.

16. Two forces of magnitude 12 N and 24 N act at the same point. Which force **cannot** be the resultant of these forces? *[1 mark]*

A. 10 N

B. 16 N

C. 19 N

D. 36 N

17. An object has a weight of 6.10×10^2 N. What is the change in gravitational potential energy of the object when it moves through 8.0 m vertically? *[1 mark]*

A. 5 kJ

B. 4.9 kJ

C. 4.88 kJ

D. 4.880 kJ

18. A boat with an output engine power of 15 kW moves through water at a speed of 10 m s^{-1}. What is the resistive force acting on the boat? *[1 mark]*

A. 0.15 kN

B. 0.75 kN

C. 1.5 kN

D. 150 kN

19. An astronaut is moving at a constant velocity in the absence of a gravitational field when he throws a tool away from him. *[1 mark]*

What is the effect of throwing the tool on the total kinetic energy of the astronaut and the tool and the total momentum of the astronaut and the tool?

	Total kinetic energy of the astronaut and tool	Total momentum of the astronaut and tool
A.	no change	increases
B.	no change	no change
C.	increases	increases
D.	increases	no change

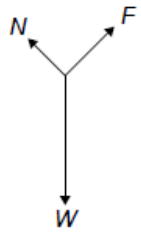
20. A table-tennis ball of mass 3 g is fired with a speed of 10 m s^{-1} from a stationary toy gun of mass 0.600 kg. The gun and ball are an isolated system. *[1 mark]*

What are the recoil speed of the toy gun and the total momentum of the system immediately after the gun is fired?

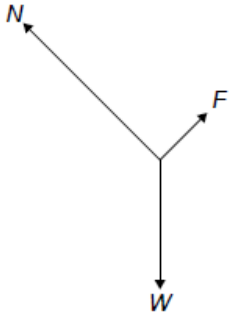
	Recoil speed of the toy gun / m s^{-1}	Total momentum of the system / kg m s^{-1}
A.	0.05	0
B.	0.05	0.03
C.	0.5	0
D.	0.5	0.03

21. A block of weight *W* slides down a ramp at constant velocity. A friction force *F* acts between the bottom of the block and the surface of the ramp. A normal reaction *N* acts between the ramp and the block. What is the free-body diagram for the forces that act on the block? *[1 mark]*

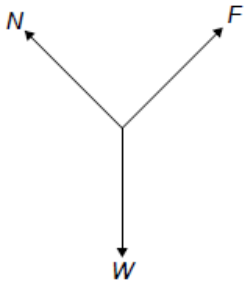
A.



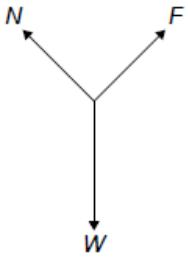
B.



C.



D.



22. A 700 W electric heater is used to heat 1 kg of water without energy losses. The specific heat capacity of water is 4.2 kJ kg^{-1} K^{-1}. What is the time taken to heat the water from 25 °C to 95 °C? *[1 mark]*

A. 7 s

B. 30 s

C. 7 minutes

D. 420 minutes

23. A container is filled with a mixture of helium and oxygen at the same temperature. The molar mass of helium is 4 g mol^{-1} and that of oxygen is 32 g mol^{-1}. *[1 mark]*

What is the ratio $\frac{\text{average speed of helium molecules}}{\text{average speed of oxygen molecules}}$?

A. $\frac{1}{8}$

B. $\frac{1}{\sqrt{8}}$

C. $\sqrt{8}$

D. 8

24. Container X contains 1.0 mol of an ideal gas. Container Y contains 2.0 mol of the ideal gas. Y has four times the volume of X. The pressure in X is twice that in Y. *[1 mark]*

What is $\frac{\text{temperature of gas in X}}{\text{temperature of gas in Y}}$?

A. $\frac{1}{4}$

B. $\frac{1}{2}$

C. 1

D. 2

25. A truck has an initial speed of 20 m s^{-1}. It decelerates at 4.0 m s^{-2}. What is the distance taken by the truck to stop? *[1 mark]*

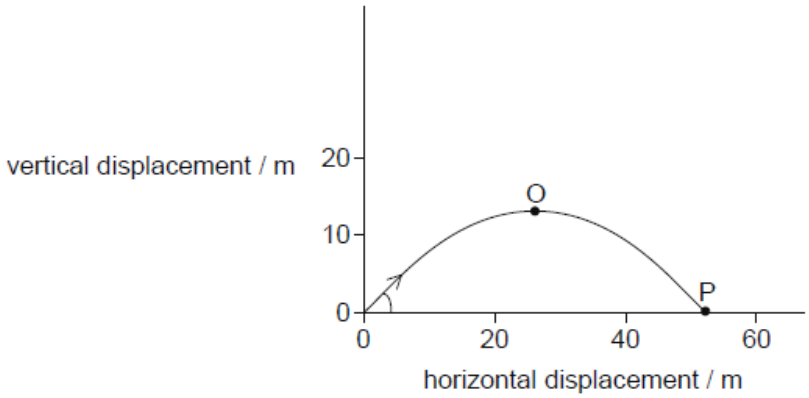
A. 2.5 m

B. 5.0 m

C. 50 m

D. 100 m

26. A projectile is fired at an angle to the horizontal. Air resistance is negligible. The path of the projectile is shown. *[1 mark]*

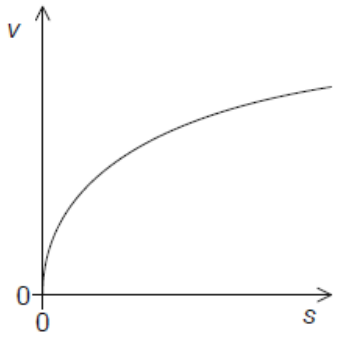


Which gives the magnitude of the horizontal component and the magnitude of the vertical component of the velocity of the projectile between O and P?

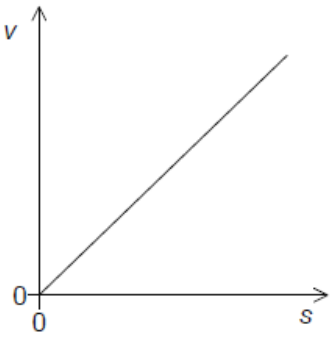
	Magnitude of horizontal component of velocity	Magnitude of vertical component of velocity
A.	constant	increases
B.	constant	constant
C.	increases	increases
D.	increases	constant

27. A runner starts from rest and accelerates at a constant rate throughout a race. Which graph shows the variation of speed v of the runner with distance travelled s? *[1 mark]*

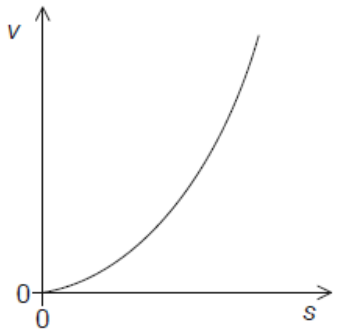
A.



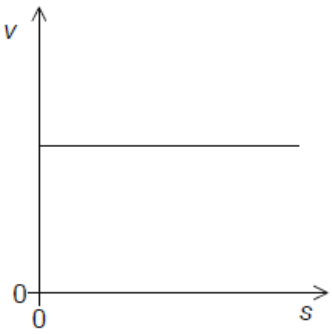
B.



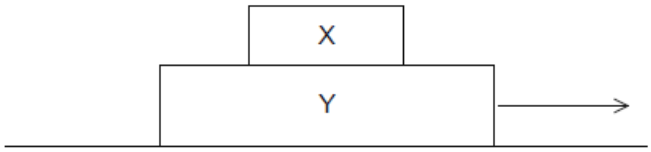
C.



D.

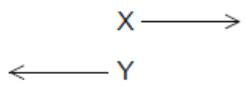


28. Two blocks X and Y rest on a frictionless horizontal surface as shown. A horizontal force is now applied to the larger block and the two blocks move together with the same speed and acceleration. *[1 mark]*

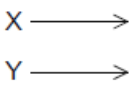


Which free-body diagram shows the frictional forces between the two blocks?

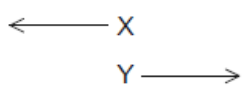
A.



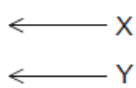
B.



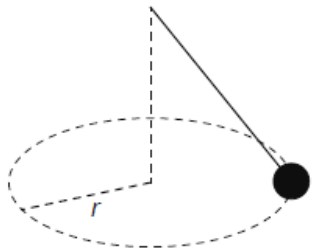
C.



D.



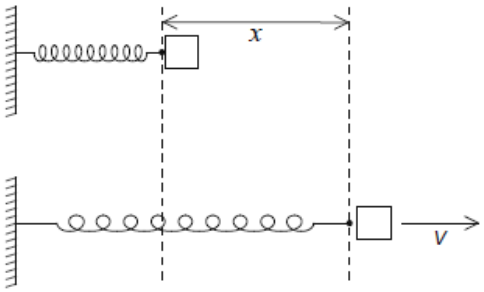
29. The mass at the end of a pendulum is made to move in a horizontal circle *[1 mark]* of radius *r* at constant speed. The magnitude of the net force on the mass is *F*.



What is the direction of *F* and the work done by *F* during half a revolution?

	Direction of *F*	Work done by *F*
A.	towards centre of circle	zero
B.	towards centre of circle	πrF
C.	away from centre of circle	zero
D.	away from centre of circle	πrF

30. A compressed spring is used to launch an object along a horizontal frictionless surface. When the spring is compressed through a distance x and released, the object leaves the spring at speed v. What is the distance through which the spring must be compressed for the object to leave the spring at $\frac{v}{2}$? *[1 mark]*



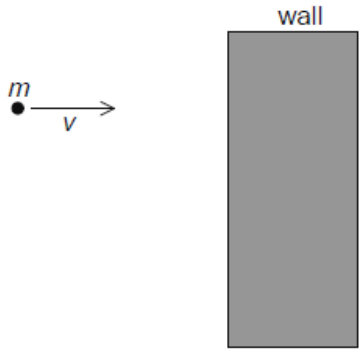
A. $\frac{x}{4}$

B. $\frac{x}{2}$

C. $\frac{x}{\sqrt{2}}$

D. $x\sqrt{2}$

31. A ball of mass *m* collides with a wall and bounces back in a straight line. The ball loses 75 % of the initial energy during the collision. The speed before the collision is *v*. *[1 mark]*



What is the magnitude of the impulse on the ball by the wall?

A. $\left(1-\frac{\sqrt{3}}{2}\right)mv$

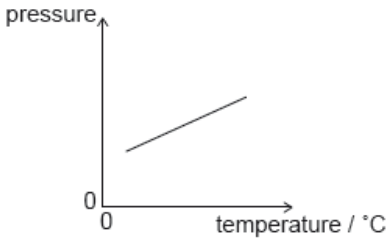
B. $\frac{1}{2}mv$

C. $\frac{5}{4}mv$

D. $\frac{3}{2}mv$

32. A fixed mass of an ideal gas is trapped in a cylinder of constant volume and its temperature is varied. Which graph shows the variation of the pressure of the gas with temperature in degrees Celsius? *[1 mark]*

A.



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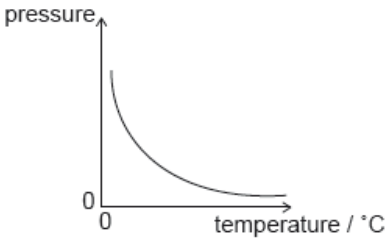
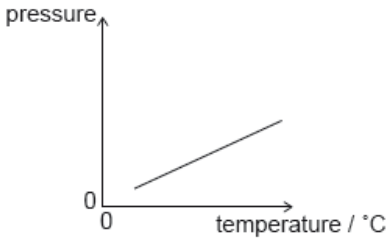
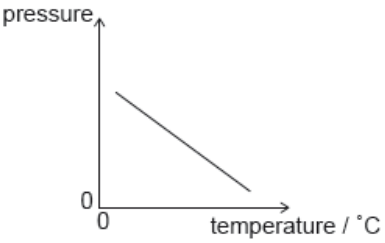


C.



D.



33. What are the units of the ratio $\frac{\text{specific heat capacity of copper}}{\text{specific latent heat of vaporization of copper}}$? *[1 mark]*

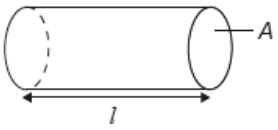
A. no units

B. k

C. k^{-1}

D. k^{-2}

34. A sealed cylinder of length *l* and cross-sectional area *A* contains *N* molecules of an ideal gas at kelvin temperature *T*. *[1 mark]*



What is the force acting on the area of the cylinder marked *A* due to the gas?

A. $\frac{NRT}{l}$

B. $\frac{NRT}{lA}$

C. $\frac{Nk_BT}{lA}$

D. $\frac{Nk_BT}{l}$

35. An object is projected vertically upwards at time $t = 0$. Air resistance is negligible. The object passes the same point above its starting position at times 2 s and 8 s. *[1 mark]*

If g = 10 m s^{-2}, what is the initial speed of the object?

A. 50

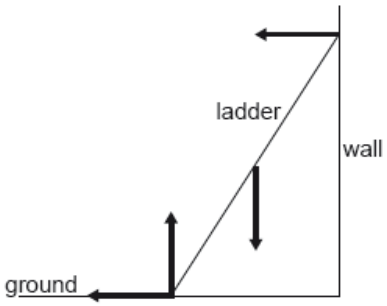
B. 30

C. 25

D. 4

36. A uniform ladder resting in equilibrium on rough ground leans against a smooth wall. Which diagram correctly shows the forces acting on the ladder? *[1 mark]*

A.



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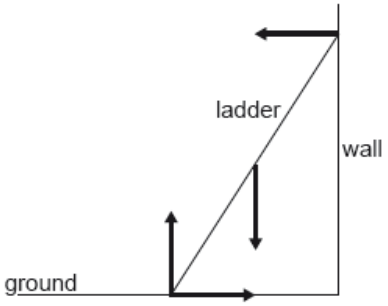

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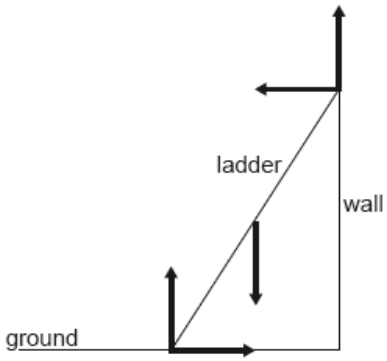
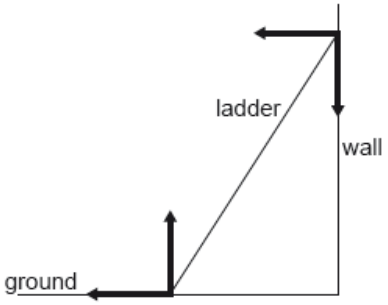


D.



37. An object falls from rest from a height *h* close to the surface of the Moon. *[1 mark]* The Moon has no atmosphere.

When the object has fallen to height $\frac{h}{4}$ above the surface, what is

$$\frac{\text{kinetic energy of the object at } \frac{h}{4}}{\text{gravitational potential energy of the object at } h}?$$

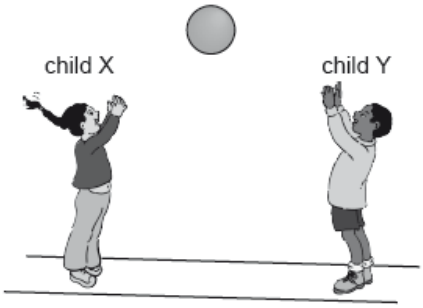
A. $\frac{3}{4}$

B. $\frac{4}{3}$

C. $\frac{9}{16}$

D. $\frac{16}{9}$

38. Child X throws a ball to child Y. The system consists of the ball, the children and the Earth. What is true for the system when the ball has been caught by Y? *[1 mark]*



[Source: https://pixabay.com/en/playing-ball-kids-boy-girl-31339/]

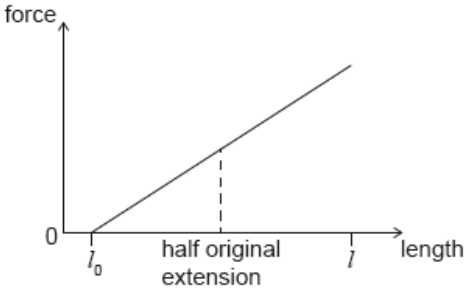
A. The momentum of child Y is equal and opposite to the momentum of child X.

B. The speed of rotation of the Earth will have changed.

C. The ball has no net momentum while it is in the air.

D. The total momentum of the system has not changed.

39. An increasing force acts on a metal wire and the wire extends from an initial length l_0 to a new length l. The graph shows the variation of force with length for the wire. The energy required to extend the wire from l_0 to l is E. *[1 mark]*



The wire then contracts to half its original extension.

What is the work done by the wire as it contracts?

A. $0.25E$

B. $0.50E$

C. $0.75E$

D. E

40. The distances between successive positions of a moving car, measured at equal time intervals, are shown. *[1 mark]*

The car moves with

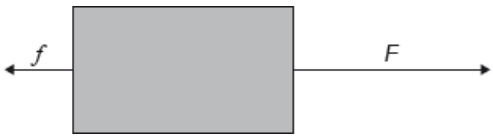
A. acceleration that increases linearly with time.

B. acceleration that increases non-linearly with time.

C. constant speed.

D. constant acceleration.

41. An object is moving in a straight line. A force F and a resistive force f act on the object along the straight line. *[1 mark]*



Both forces act for a time t.

What is the rate of change of momentum with time of the object during time t?

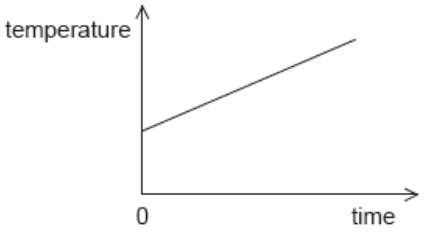
A. $F + f$

B. $F - f$

C. $(F + f)t$

D. $(F - f)t$

42. The graph shows how the temperature of a liquid varies with time when energy is supplied to the liquid at a constant rate P. The gradient of the graph is K and the liquid has a specific heat capacity c. *[1 mark]*



What is the mass of the liquid?

A. $\frac{P}{cK}$

B. $\frac{PK}{c}$

C. $\frac{Pc}{K}$

D. $\frac{cK}{P}$

43. A container that contains a fixed mass of an ideal gas is at rest on a truck. The truck now moves away horizontally at a constant velocity. What is the change, if any, in the internal energy of the gas and the change, if any, in the temperature of the gas when the truck has been travelling for some time? *[1 mark]*

	Change in internal energy	Change in temperature
A.	unchanged	unchanged
B.	unchanged	increased
C.	increased	unchanged
D.	increased	increased

44. A sealed container contains water at 5 °C and ice at 0 °C. This system is thermally isolated from its surroundings. What happens to the total internal energy of the system? *[1 mark]*

A. It remains the same.

B. It decreases.

C. It increases until the ice melts and then remains the same.

D. It increases.

45. A motor of input power 160 W raises a mass of 8.0 kg vertically at a constant speed of 0.50 m s^{-1}. *[1 mark]*

What is the efficiency of the system?

A. 0.63%

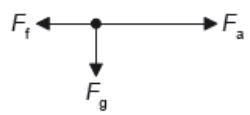
B. 25%

C. 50%

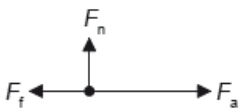
D. 100%

46. A box is accelerated to the right across rough ground by a horizontal force F_a. The force of friction is F_f. The weight of the box is F_g and the normal reaction is F_n. Which is the free-body diagram for this situation? *[1 mark]*

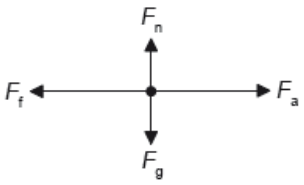
A.



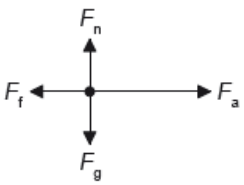
B.



C.

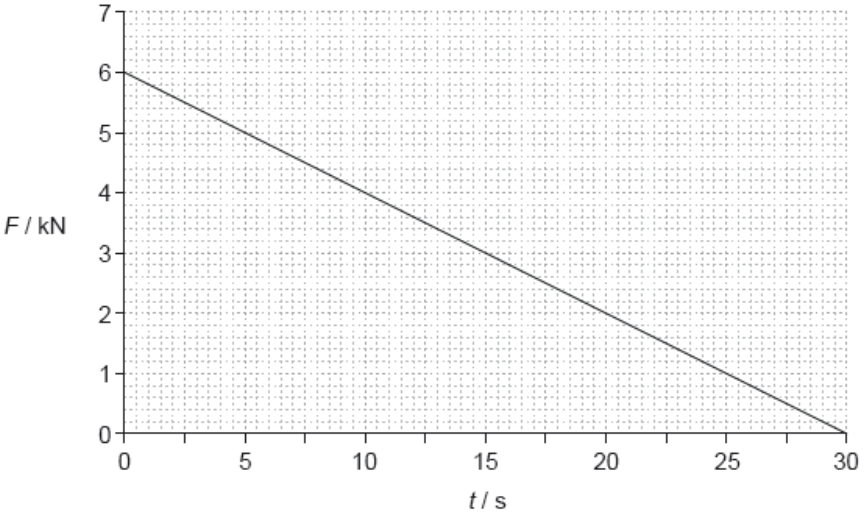


D.



47. The graph shows the variation with time t of the force F acting on an object of mass 15 000 kg. *[1 mark]*

The object is at rest at $t = 0$.



What is the speed of the object when $t = 30$ s?

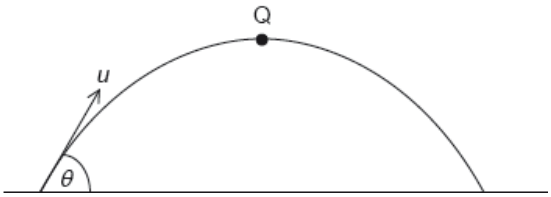
A. 0.18 m s^{-1}

B. 6 m s^{-1}

C. 12 m s^{-1}

D. 180 m s^{-1}

48. A ball of mass m is thrown with an initial speed of u at an angle θ to the horizontal as shown. Q is the highest point of the motion. Air resistance is negligible. *[1 mark]*



What is the momentum of the ball at Q?

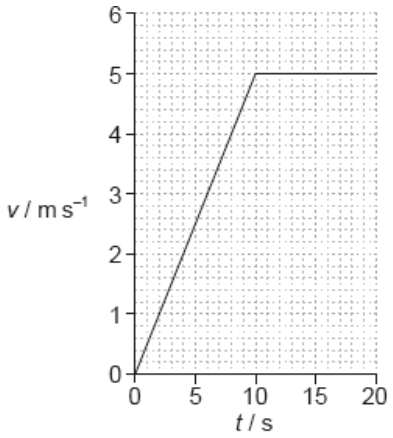
A. zero

B. $mu\cos\theta$

C. mu

D. $mu\sin\theta$

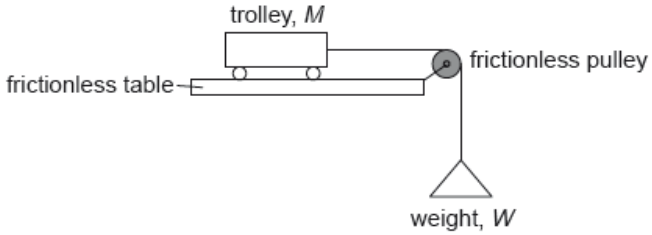
49. A boy runs along a straight horizontal track. The graph shows how his speed v varies with time t. *[1 mark]*



After 15 s the boy has run 50 m. What is his instantaneous speed and his average speed when $t = 15$ s?

	Instantaneous speed / m s^{-1}	Average speed / m s^{-1}
A.	3.3	3.3
B.	3.3	5.0
C.	5.0	3.3
D.	5.0	5.0

50. A weight W is tied to a trolley of mass M by a light string passing over a frictionless pulley. The trolley has an acceleration a on a frictionless table. The acceleration due to gravity is g. *[1 mark]*



What is W?

A. $\frac{Mag}{(g-a)}$

B. $\frac{Mag}{(g+a)}$

C. $\frac{Ma}{(g-a)}$

D. $\frac{Ma}{(g+a)}$

51. Two balls X and Y with the same diameter are fired horizontally with the same initial momentum from the same height above the ground. The mass of X is greater than the mass of Y. Air resistance is negligible. *[1 mark]*

What is correct about the horizontal distances travelled by X and Y and the times taken by X and Y to reach the ground?

	Horizontal distances	Time to reach ground
A.	X and Y the same	X and Y times the same
B.	X and Y the same	X takes a shorter time than Y
C.	X less than Y	X and Y times the same
D.	X less than Y	X takes a shorter time than Y

52. A 1.0 kW heater supplies energy to a liquid of mass 0.50 kg. The temperature of the liquid changes by 80 K in a time of 200 s. The specific heat capacity of the liquid is 4.0 kJ kg^{-1} K^{-1}. What is the average power lost by the liquid? *[1 mark]*

A. 0

B. 200 W

C. 800 W

D. 1600 W

53. Under what conditions of pressure and temperature does a real gas approximate to an ideal gas? *[1 mark]*

	Pressure	Temperature
A.	high	high
B.	high	low
C.	low	high
D.	low	low

54. The variation of the displacement of an object with time is shown on a graph. What does the area under the graph represent? *[1 mark]*

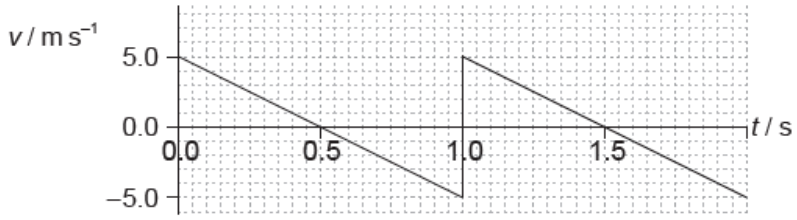
A. No physical quantity

B. Velocity

C. Acceleration

D. Impulse

55. An object is thrown upwards. The graph shows the variation with time *t* of the velocity *v* of the object. *[1 mark]*



What is the total displacement at a time of 1.5 s, measured from the point of release?

A. 0 m

B. 1.25 m

C. 2.50 m

D. 3.75 m

56. An object is released from a stationary hot air balloon at height *h* above the ground. *[1 mark]*

An identical object is released at height *h* above the ground from another balloon that is rising at constant speed. Air resistance is negligible. What does **not** increase for the object released from the rising balloon?

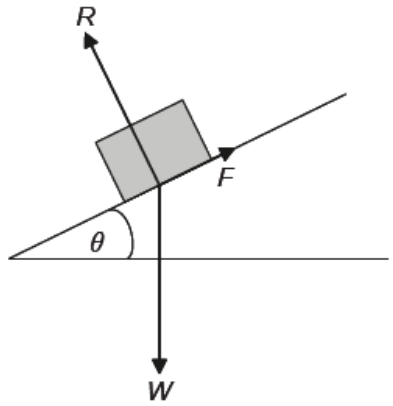
A. The distance through which it falls

B. The time taken for it to reach the ground

C. The speed with which it reaches the ground

D. Its acceleration

57. The diagram shows the forces acting on a block resting on an inclined plane. The angle θ is adjusted until the block is just at the point of sliding. R is the normal reaction, W the weight of the block and F the maximum frictional force. *[1 mark]*



not to scale

What is the maximum coefficient of static friction between the block and the plane?

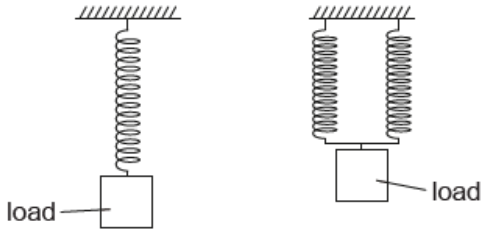
A. sin θ

B. cos θ

C. tan θ

D. $\frac{1}{\tan\theta}$

58. A system that consists of a single spring stores a total elastic potential energy E_p when a load is added to the spring. Another identical spring connected in parallel is added to the system. The same load is now applied to the parallel springs. *[1 mark]*



single spring parallel springs

What is the total elastic potential energy stored in the changed system?

A. E_p

B. $\frac{E_p}{2}$

C. $\frac{E_p}{4}$

D. $\frac{E_p}{8}$

59. A moving system undergoes an explosion. What is correct for the momentum of the system and the kinetic energy of the system when they are compared immediately before and after the explosion? *[1 mark]*

	Momentum	Kinetic energy
A.	conserved	increased
B.	conserved	conserved
C.	increased	conserved
D.	increased	increased

60. What does the constant n represent in the equation of state for an ideal gas $pV = nRT$? *[1 mark]*

A. The number of atoms in the gas

B. The number of moles of the gas

C. The number of molecules of the gas

D. The number of particles in the gas