EXAM-STYLE QUESTIONS

Multiple choice questions

1 An object of mass 2.5 kg falls vertically through the air with a downwards acceleration of 4.81 ms^{-2}. Taking g = 9.81 ms^{-2}, the size of the air resistance force acting on the object is

A Zero.

B 5.81 N.

C 12.5 N.

D 24.5 N.

2 Here are three statements about an object in motion:

One: An object that is not accelerating must have a constant speed.

Two: An object that is travelling at a constant speed cannot be accelerating.

Three: An object that travels at a constant speed for a period of time cannot have zero displacement.

Which of the following combinations of these three statements is **true**?

A One only

B One and Three only

C Two and Three only

D One, Two and Three

3 Here are three statements about an object:

One: When all the forces acting on an object are balanced, the object must be stationary.

Two: When all the forces acting on an object are balanced, the object cannot be accelerating.

Three: When all the forces acting on an object are balanced, the object can be changing direction as long as its speed is not changing.

Which of the following combinations of the statements is correct?

A One only

B Two only

C One and Two only

D Two and Three only

4 An object starts from rest and accelerates uniformly at a rate of 5 ms^{-2} for 6 s. The distance travelled by the object after 6 s is

A 15 m.

B 30 m.

C 90 m.

D 180 m.

5 An object of mass 25 kg collides with, and exerts a force of 900 N on, an object of mass 100 kg. Which of the following gives the magnitude of the force that the 100 kg mass exerts on the 25 kg mass?

A Zero

B 225 N

C 900 N

D 3600 N

6 A block of wood floats on the surface of some water. Which of the following statements about the block may be incorrect?

A The net vertical force on the block is zero.

B The density of the block is the same as the density of water.

C The buoyancy force acting on the block is equal in size to the weight of the block.

D The density of the block cannot be greater than the density of water.

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7 Figure 2.7 shows a block of stone resting on a slope. The weight of the block is W, and the normal contact force between the and the slope is N. The frictional force between the block and the slope is F. At the angle θ, the block just starts to slide down slope. If the coefficient of static friction between the block and the slope is μ, which of the following statements is correct?

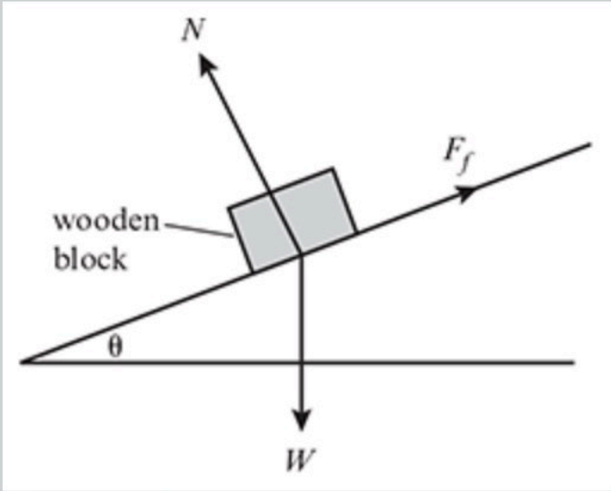

Figure 2.7

A $W = \mu N$

B $W \cos \theta = \mu N$

C $W \sin \theta = \mu N$

D $W \sin \theta = N$

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8 A mass of 300 g is hung from a spring of unstretched length 12.0 cm. The mass causes the spring's length to become 16.0 cm. Which of the following is the best estimate of the spring constant of the spring?

A 0.8 Nm^{-1}

B 1.9 Nm^{-1}

C 7.5 Nm^{-1}

D 75 Nm^{-1}

9 Callisto and Europa are both moons of Jupiter. Here are some data about the two moons and their circular orbits:

- Europa's average speed in orbit is 1.7 times that of Callisto's average speed in orbit.
- Europa's mass is 0.43 times that of Callisto's mass.
- Europa's orbital radius is 0.35 times that of Callisto's orbital radius.

Which of the following is the best estimate of the ratio of the centripetal force acting on Europa to the centripetal force acting on Callisto?

A 0.28

B 1.0

C 2.1

D 3.6

10 A ball of mass m is attached to the end of a light string. The ball is made to rotate in a vertical circle of radius r so that it makes one complete rotation in a time T. When the ball is directly above the centre of the circular path, which of the following expressions gives the tension in the string?

A $\frac{4\pi^2 mr}{T^2}$

B $m\left(g - \frac{4\pi^2 r}{T^2}\right)$

C $m\left(g + \frac{4\pi^2 r}{T^2}\right)$

D $m\left(\frac{4\pi^2 r}{T^2} - g\right)$

Short-answer questions

11 A coal barge travels along a canal at a constant speed in the direction shown by the dotted line in Figure 2.8. The barge is pulled by two ropes, A and B such that the tension in rope A is 4.0 kN.

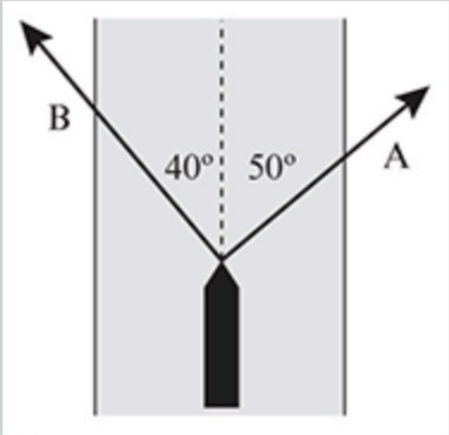

Figure 2.8

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a Calculate the size of the tension in rope B. **[2]**

b Calculate the frictional drag force, F_d, between the barge and the water in the canal. **[1]**

c The same barge is now pulled by two ropes in the same direction as those in Figure 2.8 during a very hot day (when the temperature of the water is increased) so that the speed of the barge is the same as it had been before.

i State how the tension in the two ropes would have to differ. **[1]**

ii Give a reason to support your statement. **[1]**

12 A spring of unstretched length 4.0 cm has a spring constant of 25 Nm^{-1}.

a Calculate the length of the spring when a stretching force of 5 N is applied to it. **[2]**

b If four such springs were connected end to end to make a longer spring of new length 16.0 cm, determine the extension of the longer spring if a stretching force of 5 N is applied to it. **[1]**

c Calculate how many such springs would be required to be connected in parallel if a stretching force of 8 N causes an extension of 2 cm. **[1]**

13 A 4.0 kg mass rests on a set of weighing scales on the floor of an elevator. Complete the following table to show the reading you would expect from the weighing scales under the conditions of motion given. (g = 10 Nkg^{-1}) **[5]**

Motion of elevator	Reading on weighing scales / N
Stationary	
Moving upwards at 2.5 ms^{-1}	
Moving downwards at 2.5 ms^{-1}	
Accelerating upwards at 2.5 ms^{-2}	
Accelerating downwards at 2.5 ms^{-2}	

14 An amulet of mass 120 g hangs on a light necklace which is attached to the rear-view mirror of a car. When the car accelerates, the amulet moves backwards so that the necklace makes an angle of 20° with the vertical.

a Calculate the tension in the necklace when the car is accelerating. **[2]**

b Calculate the car's acceleration. **[1]**

After travelling at a constant speed for a while, the car now decelerates at 5 ms^{-2}.

c Determine what would happen to the amulet and necklace. **[2]**

15 A cricket ball of mass 125 g travelling at 40 ms^{-1} is caught by an inexperienced fielder. The fielder holds his hands, each of mass 400 g, rigidly still during the catch, which takes 0.2 s.

a Calculate the average force applied by the fielder's hands to catch the ball. **[2]**

b State the size of the force exerted by the ball on the fielder's hands. **[1]**

One of the fielder's teammates suggests that next time he takes a catch, he should allow his hands to move backwards a little during the catch.

c With reference to Newton's second and third laws, explain why the fielder should follow his teammate's advice. **[2]**

16 Figure 2.9 shows a rectangular block of mass 12 kg sitting on a rough inclined plane.

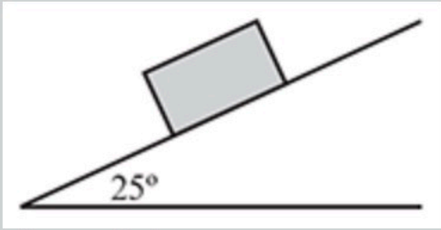

Figure 2.9

a Add to the diagram to show all of the forces acting on the block. **[2]**

b If the angle that the inclined plane makes with the horizontal were to be increased—even by a very small amount—the block will start to slide down the slope. Determine the coefficient of static friction between the block and the inclined plane. **[1]**

c If the block were replaced by another block of the same material but of twice the mass, would the block still remain static? Explain your answer. **[2]**

17 During a thunderstorm a spherical hail stone of radius 3 mm falls through the air at a constant speed.

a Calculate the weight of the hailstone. (density of ice = 920 kgm^{-3} and g = 9.81 Nkg^{-1}) **[1]**

b If the viscosity of air is 1.8×10^{-5} Nsm^{-2}, calculate the speed at which the hailstone is falling. **[2]**

c The frictional forces between the hailstone and the air cause the hailstone to melt without any loss of mass during its journey downwards, turning it into a raindrop.

i Given that the density of water is 1000 kgm^{-3}, would you expect the raindrop to fall at a smaller speed, the same speed or a higher speed compared to the hailstone? **[1]**

ii Justify your answer. **[1]**

18 A geostationary satellite has an orbital radius of 4.23×10^{7} m and takes exactly one day to orbit the Earth. Calculate

a the angular speed of the satellite, ω. **[1]**

b the linear speed at which the satellite is travelling, v. **[1]**

c the value of the Earth's gravitational field strength at this distance from the Earth. **[2]**

19 A car of mass 1250 kg travels at a constant speed along a curve in the road which is the arc of a circle of radius 75 m.

a State the force that provides the centripetal force necessary for the circular motion of the car. **[1]**

b Calculate the maximum speed at which the car can travel without skidding. (μ_S = 0.7) **[2]**

c A truck, of double the mass of the car, follows the same path as the car.

If the coefficient of static friction remains the same, state the maximum speed at which the truck can travel without skidding. **[1]**

20 Sometimes, in competition ice skating, a male skater swings his partner around in a circle. If the skater's arm makes an angle of 30° with the horizontal, and his 60 kg partner rotates around a circle of radius 2.2 m, calculate

a the tension in the male skater's arm. **[2]**

b the angular speed of his partner. **[2]**

c the linear speed of his partner. **[1]**