EXAM-STYLE QUESTIONS

Multiple-choice questions

1 Which of the following statements about momentum, p, is correct?

A $p = \frac{1}{2}mv^2$

B $p = Ft$

C $p = mv$

D $p = \frac{F}{t}$

2 When two objects collide elastically, which of the following combinations of kinetic energy and momentum is correct?

A Kinetic energy = conserved; momentum = conserved

B Kinetic energy = not conserved; momentum = conserved

C Kinetic energy = conserved; momentum = not conserved

D Kinetic energy = not conserved; momentum = not conserved

3 A car of mass 1250 kg accelerates from 10 ms^{-1} to 24 ms^{-1} in 7.0 s. The impulse felt by the car is

A 2500 N s.

B 8750 N s.

C 17 500 N s.

D 122 500 N s.

4 Which of the following expressions gives the correct units for impulse?

A N

B Ns^{-1}

C Nms^{-1}

D N s

5 Which of the following gives the correct units for power?

A $kgms^{-2}$

B kgm^2s^{-2}

C kgm^2s^{-3}

D kgm^3s^{-3}

6 The area under a graph of *force* against *time* gives

A final velocity.

B final momentum.

C impulse.

D power.

7 The gradient of a graph of *momentum* against *time* gives

A force.

B impulse.

C average momentum.

D acceleration.

8 A rubber ball, of mass 250 g, travelling at 4.0 ms^{-1} hits a wall perpendicularly and bounces off with a speed of 3.0 ms^{-1}. The time of impact is 0.2 s.

Which of the following gives the best estimate of the average force exerted by the wall on the rubber ball?

A 0.25 N

B 1.25 N

C 8.75 N

D 50.0 N

9 Which of the following expressions is a correct relationship between kinetic energy, E_K, and momentum, p?

A $E_K = \frac{mp^2}{2}$

B $E_K = \left(\frac{p}{2m}\right)^2$

C $E_K = \frac{p^2}{m}$

D $E_K = \frac{p^2}{2m}$

10 The momentum of a 4.0 kg mass with a kinetic energy of 200 J is

A 20 $kgms^{-1}$.

B 40 $kgms^{-1}$.

C 60 $kgms^{-1}$.

D 80 $kgms^{-1}$.

Short-answer questions

11 In a vehicle test centre, a car of mass 1200 kg crashes into a solid wall at a speed of 18 ms^{-1}. The car is not equipped with crumple zones. If the average stopping force exerted by the wall on the car is 3.0×10^5 N,

a calculate the time it takes for the car to come to a stop. **[2]**

b calculate how far a passenger not wearing a seatbelt would have travelled during the stopping of the car. **[1]**

c discuss why the wearing of seatbelts in a car is compulsory. **[1]**

12 A body of mass 6 kg moving horizontally at a speed of 6 ms^{-1} collides with, and sticks to, a stationary mass of 3 kg. The collision between the two masses lasted for a time of 0.2 s.

a Calculate the speed of the combined masses after the collision. **[2]**

b Show that the force experienced by the 3 kg mass was 60 N. **[1]**

c Determine whether the collision was elastic or inelastic. **[2]**

13 A car and a truck, both travelling at the same speed of 60 kmh^{-1} but in opposite directions, collide head-on. The truck has **twice** the mass of the car.

a During the collision, how does the force experienced by the truck compare to the force experienced by the car? Explain your answer using one of Newton's laws of motion. **[1]**

b If the two vehicles become entangled during the collision, calculate the speed of the vehicles immediately after the collision. **[2]**

c Show that the collision was inelastic. **[2]**

14 The momentum of a 3.0 kg mass increases uniformly from zero to 15 kg ms^{-1} in a time of 20 s.
Calculate the:

a average force being experienced by the object. **[2]**

b change in kinetic energy of the object during the 20 s period. **[2]**

15 In the alpha-decay of an Americium-241 nucleus, a $^{237}_{93}Np$ nucleus moves away at a speed, *v*, while the alpha-particle moves away at a speed of 1.6×10^{7} ms^{-1} in the opposite direction. The relative masses of the two particles are 237 and 4.

a Determine the speed at which the $^{237}_{93}Np$ nucleus moves after the emission of the alpha-particle. **[2]**

b How does the kinetic energy of the alpha particle compare with the kinetic energy of the $^{237}_{93}Np$ nucleus? **[2]**

16 A stationary tennis ball of mass 58 g is struck by a racket. The way in which the force applied by the racket to the ball varies with time is shown in the simplified Figure 4.2.

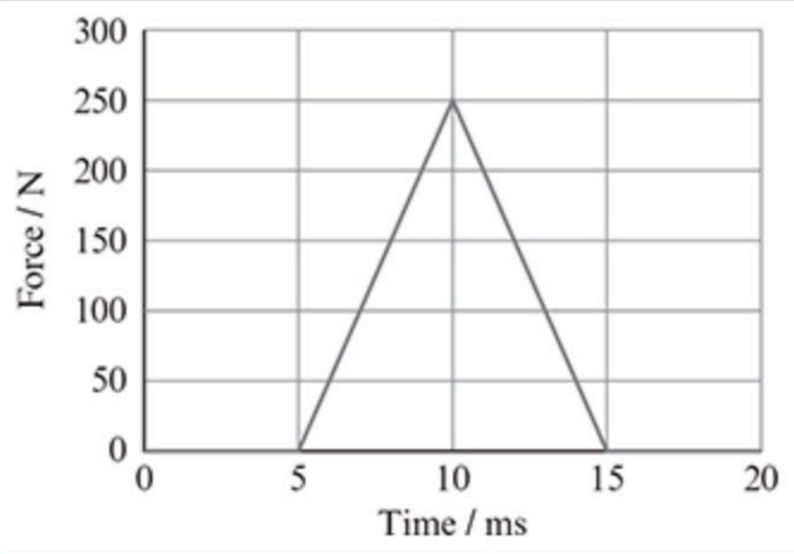

Figure 4.2

a Use the graph to determine the impulse felt by the tennis ball. **[2]**

b Hence, calculate the speed of the tennis ball after being struck by the racket. **[1]**

c If another racket with looser strings were to strike the tennis ball with the same maximum force, suggest how the speed of the tennis ball would be different, if at all, to your answer in **part b**. **[2]**

17 The graph in Figure 4.3 shows how the force acting on a toy train of mass 2.2 kg varies with time.

a Calculate the total impulse felt by the toy train. **[2]**

b Calculate the final speed of the train. **[1]**

c Calculate the average power developed by the force. **[2]**

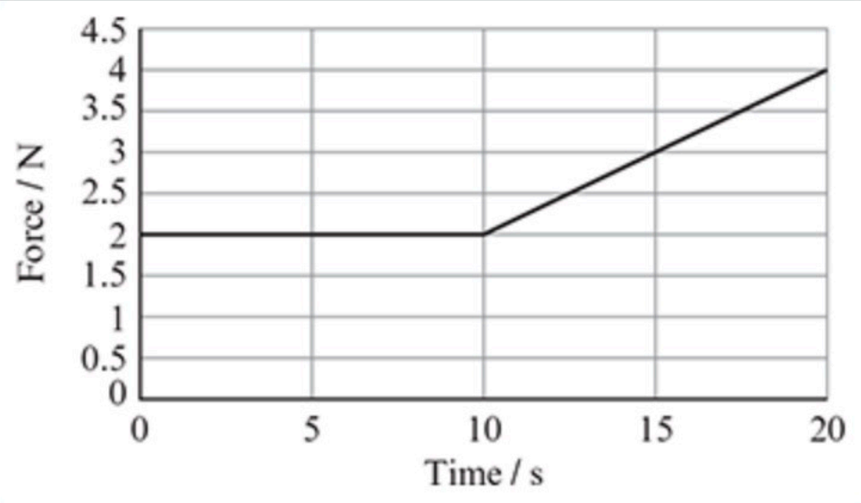

Figure 4.3

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18 In a desalination plant, salt is deposited vertically, with no appreciable kinetic energy, at a uniform rate of 30.0 kgs^{-1} onto a conveyor belt moving horizontally at a constant speed of 2.5 ms^{-1}. Giving your answers to an appropriate number of significant figures, calculate

a the force required to keep the conveyor belt moving at a constant speed. **[1]**

b the power required to maintain this constant speed. **[2]**

c change of kinetic energy of the salt after landing onto the conveyor belt. **[1]**

19 A spacecraft, of mass 12500 kg, has a rocket engine that ejects 4.0 kg of hot gas every second at a speed of 250 ms^{-1}. Calculate

a the force on the spacecraft. **[1]**

b the acceleration of the spacecraft. **[1]**

c the impulse felt by the spacecraft if the rocket engine were used for a time of 20 s. **[1]**

d the change in speed of the spacecraft. **[1]**

20 In the radioactive process of β^+ emission, a positron, of momentum 9.2×10^{-23} Ns, and a neutrino, of momentum 5.3×10^{-23} N s are emitted at right angles to each other from an unstable nucleus of mass 3.9×10^{-25} kg. Calculate

a the momentum of the new nucleus. **[3]**

b the velocity of the new nucleus. **[1]**

c the E_K of the new nucleus. **[1]**