North Berwick High School

Department of Physics

National 4/5
Dynamics and Space

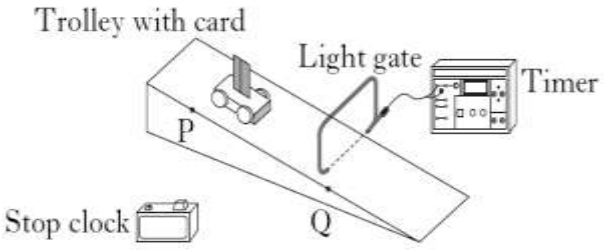
Section 1 Mechanics
Assessment Questions

Kinematics Questions

1. Which of the following is a scalar quantity?

   A Force
   B Acceleration
   C Momentum
   D Velocity
   E Energy

2. A student investigates the speed of a trolley as it moves down a slope.
   The apparatus is set up as shown.



   The following measurements are recorded.

   distance from P to Q = 1·0 m

   length of card = 0·04m

   time taken for trolley to travel from P to Q = 2·5 s

   time taken for card to pass through light gate = 0·05 s

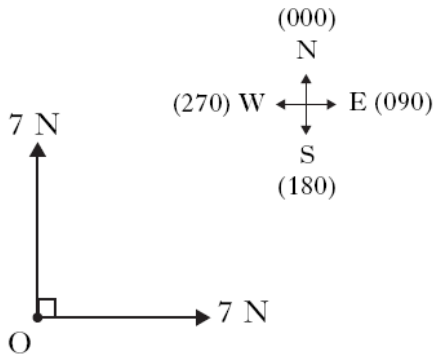
   The speed at Q is

   A 0.002 m/s
   B 0·016 m/s
   C 0.40 m/s
   D 0·80 m/s
   E 20 m/s.

3. A cross country runner travels 2.1 km North then 1.5 km East. The total time taken is 20 minutes.
   The average speed of the runner is

   A 0.18 m/s
   B 2.2 m/s
   C 3.0 m/s
   D 130 m/s
   E 180 m/s.

4. Two forces, each of 7N, act on an object O.
The forces act as shown.

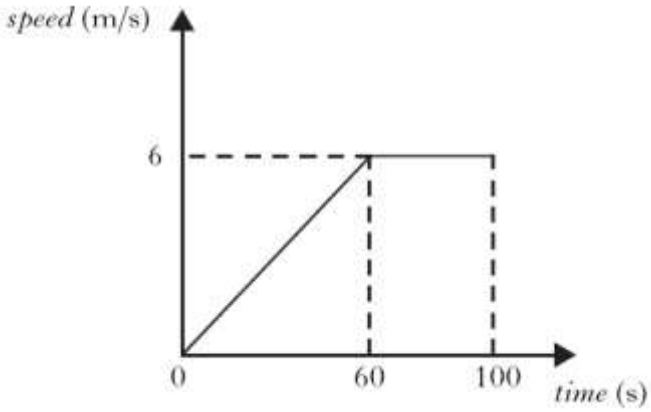


The resultant of these two forces is

A 7 N at a bearing of 135
B 9·9 N at a bearing of 045
C 9·9 N at a bearing of 135
D 14 N at a bearing of 045
E 14 N at a bearing of 135.

5. A balloon of mass 400 kg rises vertically from the ground.

The graph shows how the vertical speed of the balloon changes during the first 100 s of its upward flight.

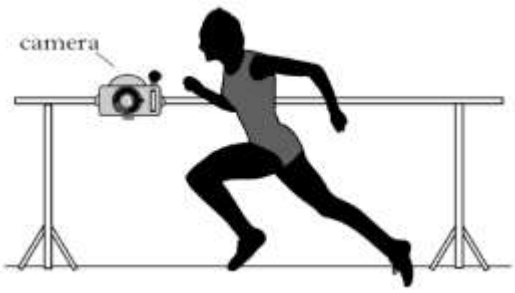


(a) Calculate the acceleration of the balloon during the first 60 s. 2

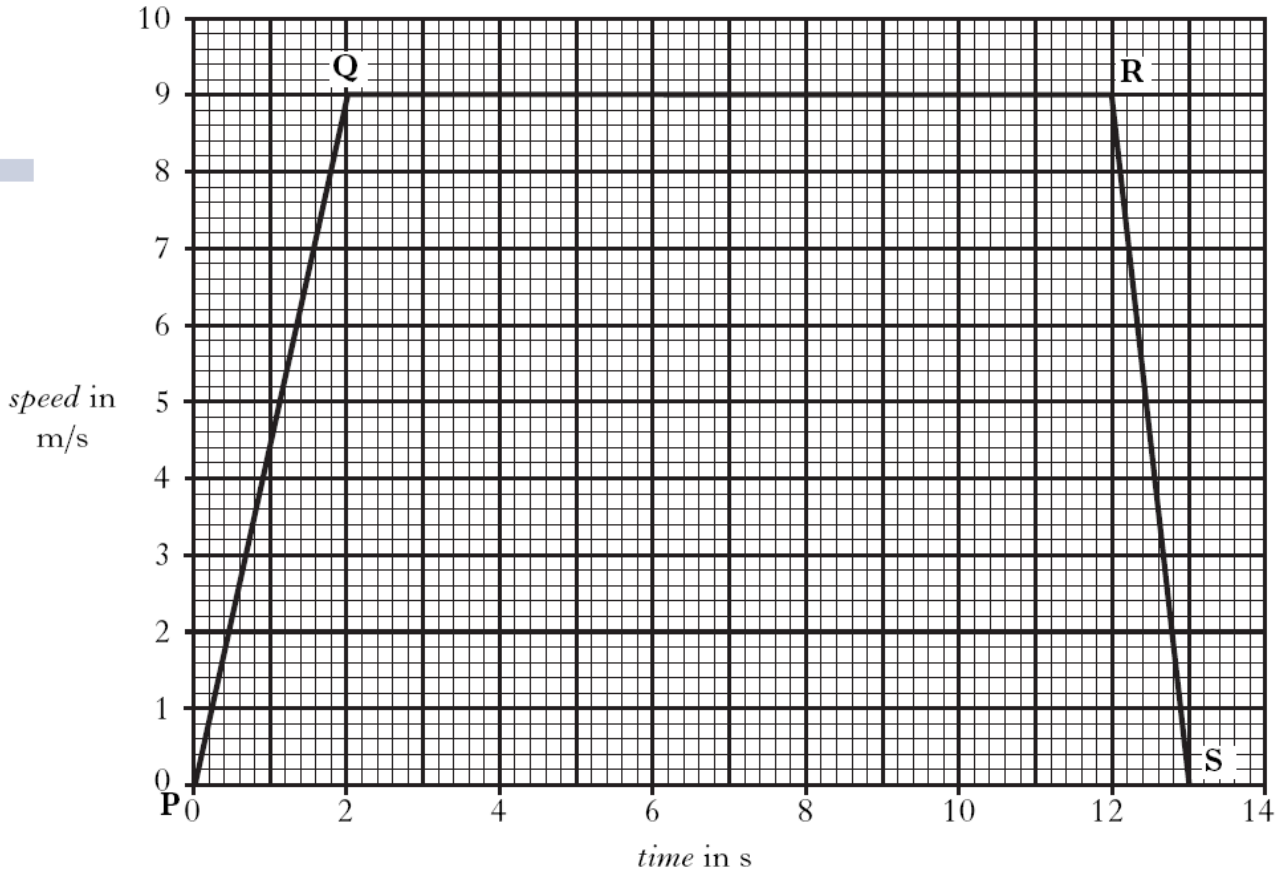
(b) Calculate the distance travelled by the balloon in 100 s. 2

(c) Calculate the average speed of the balloon during the first 100 s. 2

6. Athletes in a race are recorded by a TV camera which runs on rails beside the track.



The graph shows the speed of the camera during the race.



(a) Calculate the acceleration of the camera between **P** and **Q**. 2

(b) How far does the camera travel in the 13 s? 2

7. A cyclist rides along a road.

(a) Describe a method by which the average speed of the cyclist could be measured.
Your description must include the following

- Measurements made
- Equipment used
- Any necessary calculations. 3

(b) The cyclist approaches traffic lights at a speed of 8 m/s. He sees the traffic lights turn red and 3 s later he applies the brakes. He comes to rest in a further 2.5 s.

(i) Calculate the acceleration of the cyclist whilst braking. 2

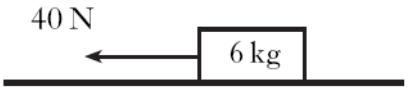
(ii) Sketch a speed time graph showing the motion of the cyclist from the moment the lights turn red until he stops at the traffic lights.

Numerical values **must** be included. 2

(iii) Calculate the total distance the cyclist travels from the moment the lights turn red until he stops at the traffic lights. 2

Dynamics Questions

1. A block of mass 6 kg is pulled across a horizontal bench by a force of 40 N as shown below.



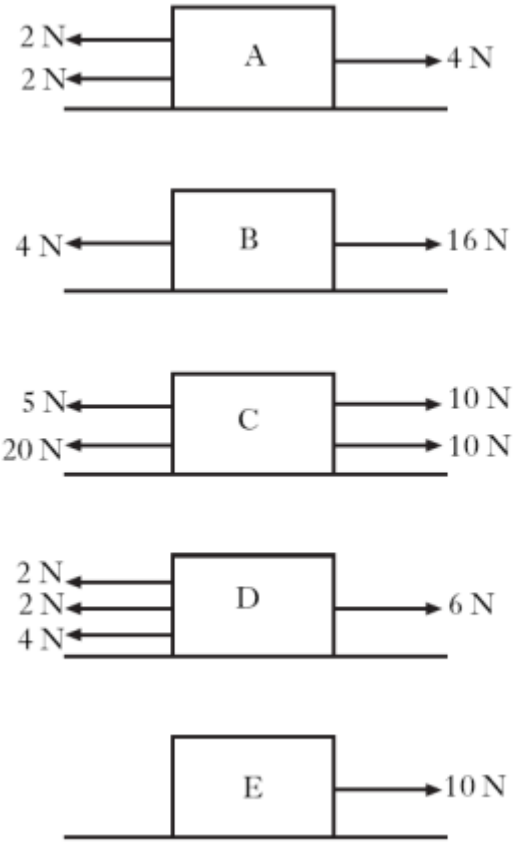
The block accelerates at 4 m/s^2.
The force of friction between the block and the bench is

A zero
B 16N
C 24N
D 40N
E 64N.

2. An unbalanced force of one newton will make a

A 0.1 kg mass accelerate at 1 m/s^2
B 1 kg mass accelerate at 1 m/s^2
C 1 kg mass accelerate at 10 m/s^2
D 0.1 kg mass move at a constant speed of 1 m/s
E 1 kg mass move at a constant speed of 10 m/s.

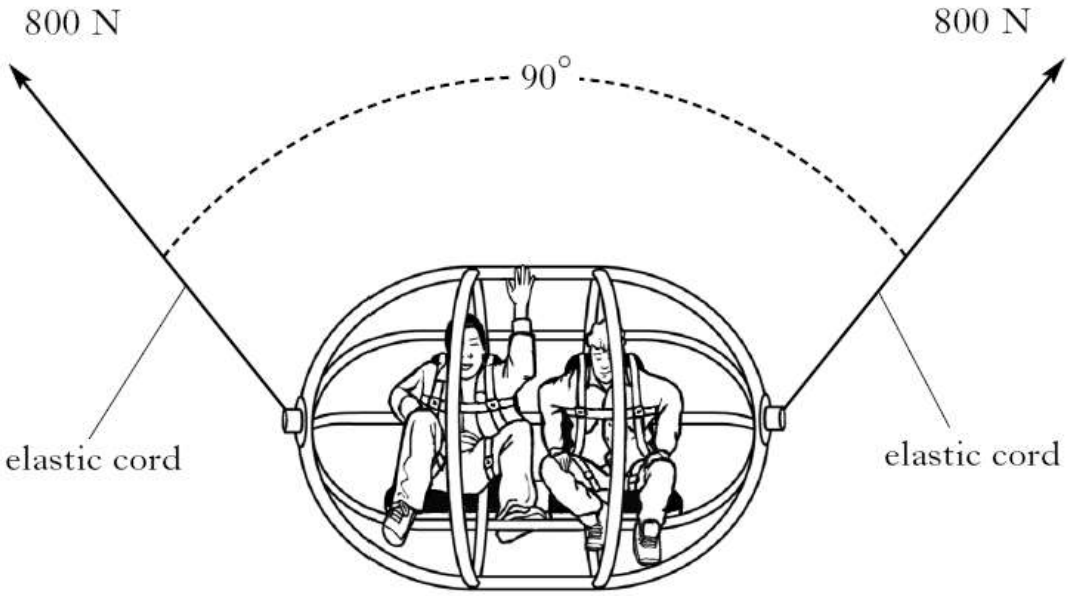
3. Which block has the largest resultant force acting on it?



4. A crate of mass 200 kg is pushed a distance of 20 m across a level floor.
The crate is pushed with a force of 150 N.
The force of friction acting on the crate is 50N.
The work done in pushing the crate across the floor is

A 1000 J
B 2000 J
C 3000 J
D 4000 J
E 20 000 J.

5. A fairground ride uses a giant catapult to launch people upwards using elastic cords.



(a) Each cord applies a force of 800 N and the cords are at 90° as shown.
Using a scale diagram, or otherwise, find the size of the resultant of these two forces.

2

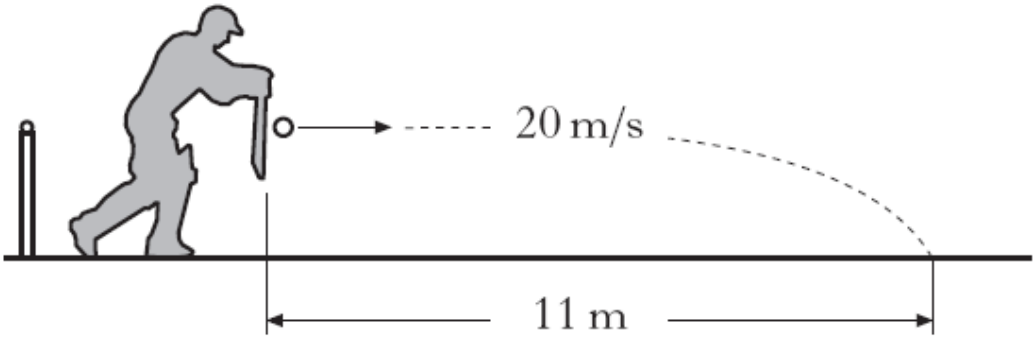
(b) The cage is now pulled further down before release.
The cords provide a total upwards force of 2700 N.
The cage and its occupants have a total mass of 180 kg.

(i) Calculate the weight of the cage and occupants.

2

(ii) Calculate the acceleration of the cage and occupants when released. 3

6. A cricketer strikes a ball. The ball leaves the bat horizontally at 20 m/s. It hits the ground at a distance of 11 m from the point where it was struck.



Assume that air resistance is negligible.

(a) Calculate the time of flight of the ball. 2

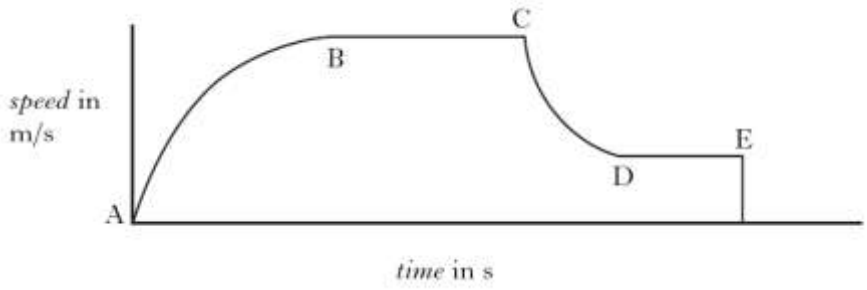
(b) Calculate the vertical speed of the ball as it reaches the ground. 2

(c) Sketch a graph of vertical speed against time for the ball. Numerical values are required on both axes. 2

(d) Calculate the vertical distance travelled by the ball during its flight. 2

7. A parachutist jumps out of an aircraft. Sometime later, the parachute is opened.

The graph shows the motion of the parachutist from leaving the aircraft until landing.



(*a*) Which parts of the graph show when the forces acting on the parachutist are balanced? 1

(*b*) The parachutist lands badly and is airlifted to hospital by helicopter.

The stretcher and parachutist have a total mass of 90·0 kg.

(i) Calculate the weight of the stretcher and parachutist. 2

(ii) The helicopter cable provides an upward force of 958·5 N to lift the stretcher and parachutist.

Calculate the acceleration of the stretcher and parachutist. 3

Energy & Power Questions

1. An arrow is fired from a bow as shown.

An archer pulls the string back a distance of 0.50 m. The string exerts an average force of 300 N on the arrow as it is fired. The mass of the arrow is 0.15 kg.

The maximum kinetic energy gained by the arrow is

A 23J
B 150 J
C 600 J
D 2000 J
E 6750 J.

2. Which row of values would result in the greatest kinetic energy?

	Mass (kilograms)	*Speed* (metres per second)
A	45	8
B	45	4
C	50	10
D	50	8
E	50	4

3. An engine applies a force of 2000 N to move a lorry at a constant speed.
The lorry travels 100 m in 16 s.

The power developed by the engine is

A 0·8 W
B 12·5 W
C 320 W
D 12 500 W
E 3 200 000 W.

4. An early method of crash testing involved a car rolling down a slope and colliding with a wall.

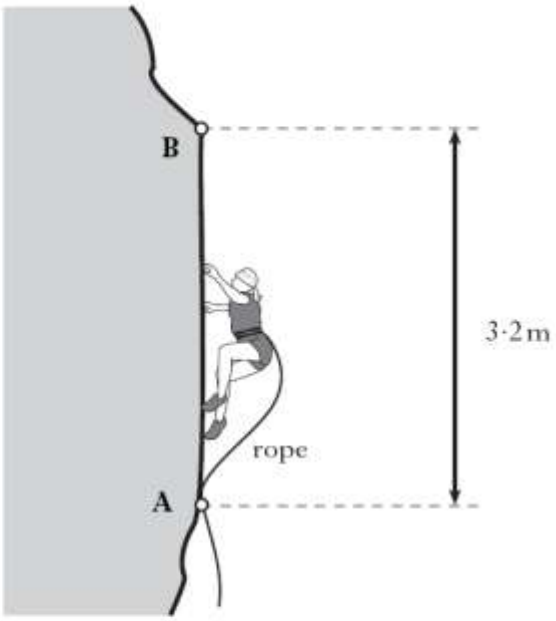
In one test, a car of mass 750 kg starts at the top of a 7.2 m high slope.

(a) Calculate the gravitational potential energy of the car at the top of the slope. 2

(b) (i) State the value of the kinetic energy of the car at the bottom of the slope, assuming no energy losses. 1

(ii) Calculate the speed of the car at the bottom of the slope, before hitting the wall. 2

5. A climber of mass 60 kg is attached by a rope to point A on a rock face. She climbs up to point B in 20 seconds. Point B is 3.2 m vertically above point A.



(a) (i) Calculate the average speed of the climber between A and B. 2

(ii) Calculate the weight of the climber. 2

(iii) Calculate her gain in potential energy. 2

(b) She then loses her footing and free falls from point B. After passing point A she is held safely by the rope.

(i) Calculate her speed as she passes point A. 2

(ii) How would her actual speed when passing point A compare with the speed calculated in (*b*) (i)?
You **must** explain your answer. 2

6. A railway train travels uphill between two stations.

Information about the train and its journey is given below.

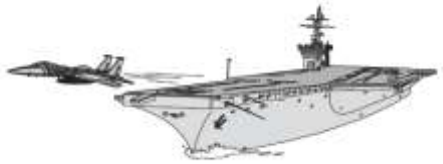
average speed of train 5 m/s
time for journey 150 s
power of train 120 kW
mass of train plus passengers 20 000 kg

(*a*) Calculate the energy used by the train during the journey. 2

(*b*) Calculate the height gained by the train during the journey. 2

(*c*) Suggest why the actual height gained by the train is less than the value calculated in part (*b*). 1

7. An aeroplane on an aircraft carrier must reach a minimum speed of 70 m/s to safely take off. The mass of the aeroplane is 28 000 kg.



(*a*) The aeroplane accelerates from rest to its minimum take off speed in 2 s.

(i) Calculate the acceleration of the aeroplane. 2

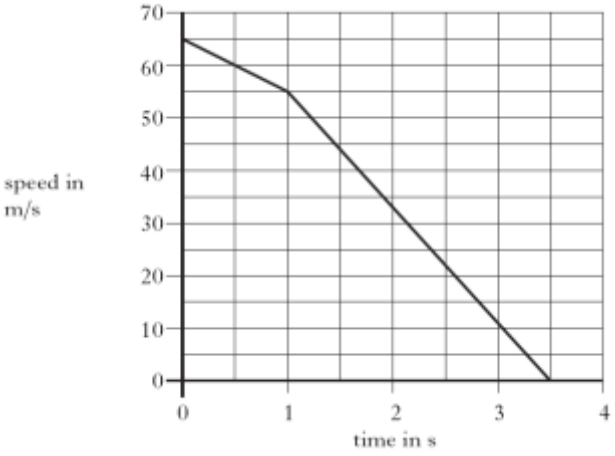
(ii) Calculate the force required to produce this acceleration. 2

(iii) The aeroplane's engines provide a total thrust of 240 kN.
An additional force is supplied by a catapult to produce the acceleration required.
Calculate the force supplied by the catapult. 1

(*b*) Later, the same aeroplane travelling at a speed of 65 m/s, touches down on the carrier.

(i) Calculate the kinetic energy of the aeroplane at this speed. 2

(ii) The graph shows the motion of the aeroplane from the point when it touches down on the carrier until it stops.



Calculate the distance travelled by the aeroplane on the carrier. 2