



VCE PHYSICS UNITS 3&4 [2020]

Unit 3 AOS 3 - How fast can things go? - Topic Exam 2

YOUR NAME: Vishnu Prasad Sivakumar

STRUCTURE OF EXAM

Section A - Multiple Choice	4 questions	5 marks
Section B - Short Answer	7 questions	38 marks
		43 marks

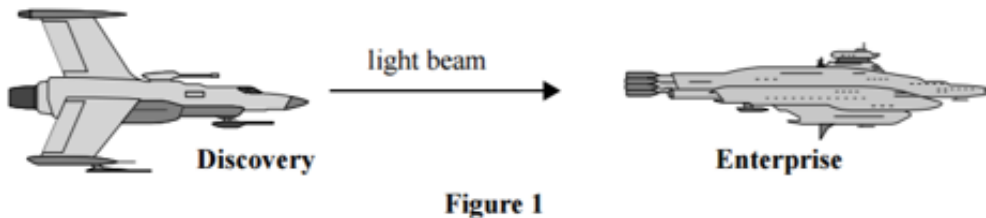
WHEN YOU FINISH

Get your marks, and view solution videos that explain the answer to each question at:

edrolo.com.au/e2819

SECTION A – MULTIPLE CHOICE**Question 1** (1 mark)

Two spaceships, Discovery and Enterprise, are both travelling relative to an inertial frame of reference at $0.8c$ in the same direction. Spaceship Discovery shines a light beam forward towards Enterprise as shown.

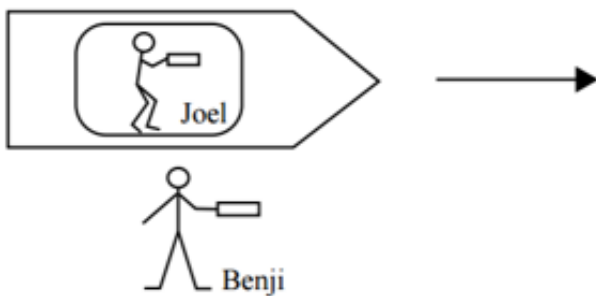


What is the speed of the light beam according to the captain on spaceship Enterprise?

- A $0.2c$
- B $0.8c$
- C c
- D $1.8c$

Question 2 (1 mark)

Astronaut Benji is floating freely in space when Joel's spaceship passes him at high speed. Benji is holding a ruler, and can see through the window of the spaceship that Joel is also holding a ruler. The two rulers are parallel to the direction of motion of the spaceship.



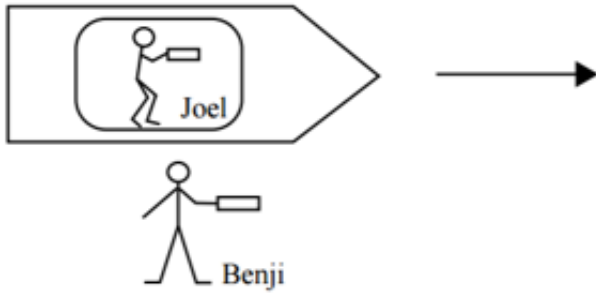
Both Benji and Joel measure the length of their own ruler to be 1.0 m . Each can see the other ruler. Benji observes Joel's ruler to be 0.6 m long.

Which one of the following gives the length of Benji's ruler as observed by Joel?

- A 0.6 m
- B 1.0 m
- C 1.4 m
- D 1.7 m

Question 3 (1 mark)

Astronaut Benji is floating freely in space when Joel's spaceship passes him at high speed. Benji is holding a ruler, and can see through the window of the spaceship that Joel is also holding a ruler. The two rulers are parallel to the direction of motion of the spaceship.



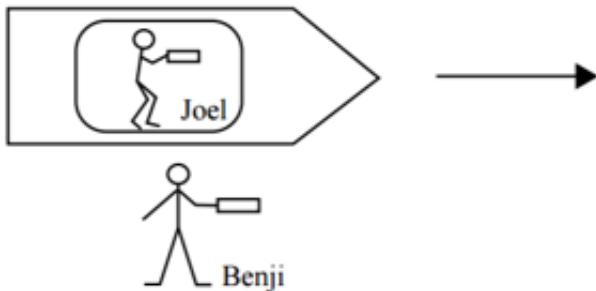
Both Benji and Joel measure the length of their own ruler to be 1.0 m. Each can see the other ruler. Benji observes Joel's ruler to be 0.6 m long.

Which one of the following gives the proper length of Joel's ruler?

- A 0.6 m
- B 1.0 m
- C 1.4 m
- D 1.7 m

Question 4 (2 marks)

Astronaut Benji is floating freely in space when Joel's spaceship passes him at high speed. Benji is holding a ruler, and can see through the window of the spaceship that Joel is also holding a ruler. The two rulers are parallel to the direction of motion of the spaceship.



Both Benji and Joel measure the length of their own ruler to be 1.0 m. Each can see the other ruler. Benji observes Joel's ruler to be 0.6 m long.

Which one of the following gives the speed of Joel's spaceship as measured by Benji?

- A 0.4 c
- B 0.6 c
- C 0.8 c
- D c

SECTION B – SHORT ANSWER**Question 1** (6 marks)

In the situation above a 32 kg dog is pulling its 65 kg owner along a path at a constant velocity. The average friction force applied backwards by the women is 430 Newtons and the leash is at an angle of 20 degrees to the horizontal.

Question 1.a

2 marks

Calculate the tension in the leash.

Question 1.b

2 marks

What is the average normal reaction force applied on the women by the pavement?

Question 1.c

1 mark

Taking the force due to gravity on the dog as the action force, what is the Newton's third law pair reaction force.

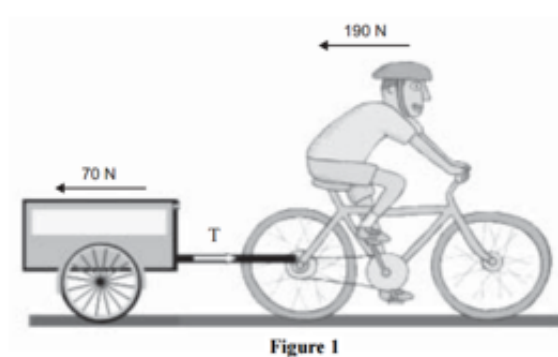
Question 1.d

1 mark

Taking the force due to gravity on the dog as the action force, what is the magnitude of this Newton's third law pair reaction force?

Question 2 (7 marks)

A cyclist is towing a small trailer along a level bike track (Figure 1). The cyclist and bike have a mass of 90 kg, and the trailer has a mass of 40 kg. There are opposing constant forces of 190 N on the rider and bike, and 70 N on the trailer. These opposing forces do not depend on the speed of the bike.



The bike and trailer are initially travelling at a constant speed of 6.0 ms^{-1} .

Question 2.a

2 marks

What driving force is being exerted on the road by the rear tyre of the bicycle?

Question 2.b

2 marks

What is the tension, T , in the bar connecting the bike to the trailer?

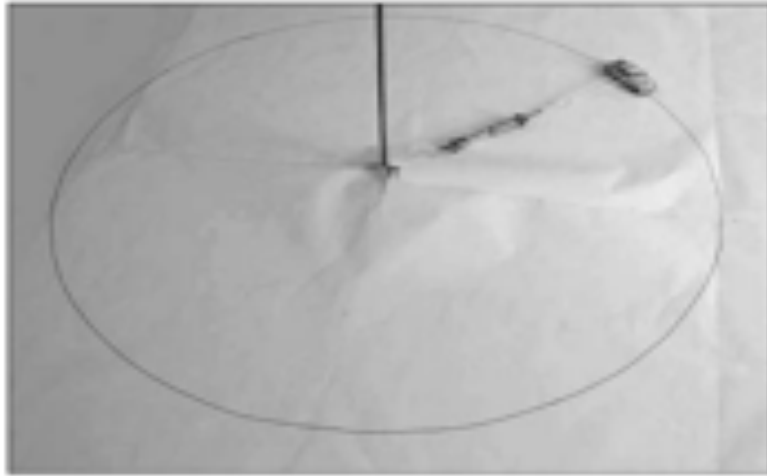
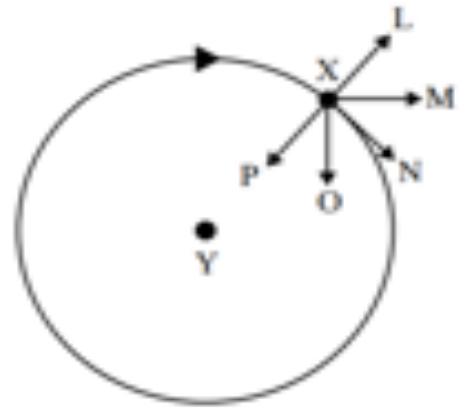
Question 2.c

3 marks

The cyclist stops pedaling and so coasts until he decelerates to rest. How far will the bike and trailer travel before they come to rest?

Question 3 (4 marks)

Students set up an experiment to investigate circular motion. They use a battery-powered model car. The car is connected with a string to a fixed point as shown in Figure 3a. A diagram of the experimental arrangement they use is shown in Figure 3b where Y represents the fixed point and X represents the car. The car has a mass of 2.4 kg. It moves at a constant speed of 2.0 m s^{-1} , around a circle of radius 1.6 m. Ignore mass of string and measuring device.

**Figure 3a****Figure 3b****Question 3.a**

2 marks

What is the tension in the string? You must show your working.

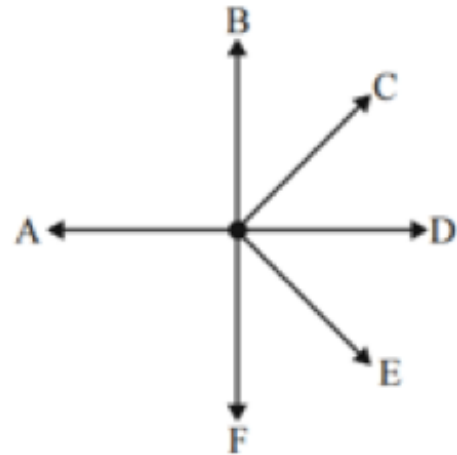
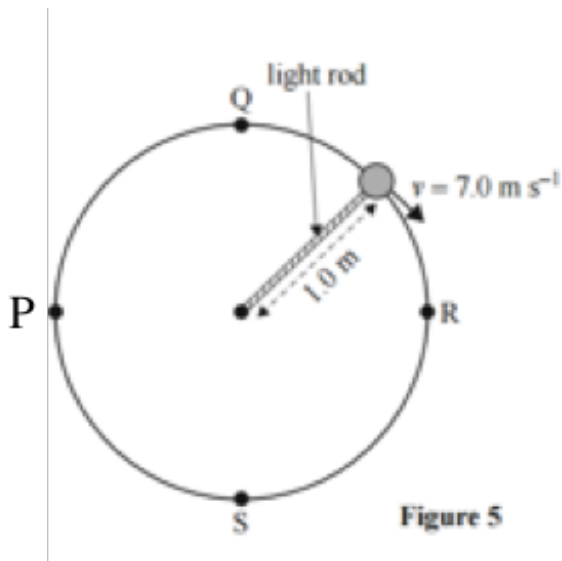
Question 3.b

2 marks

Which of the arrows (L–P) in Figure 3b best indicates the direction of the resultant force on the car when it is at the point X?

Question 4 (4 marks)

A mass of 2.0 kg is being swung by a light rod in a vertical circle of radius 1.0 m at a constant speed of 7.0 m s^{-1} , as shown in Figure 5

**Question 4.a**

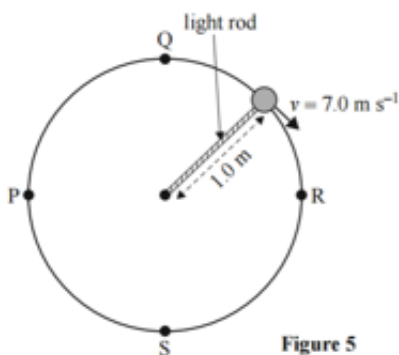
1 mark

Which of the directions (A–F) above shows the direction of the net force on the mass when it is at point P?

Question 4.b

3 marks

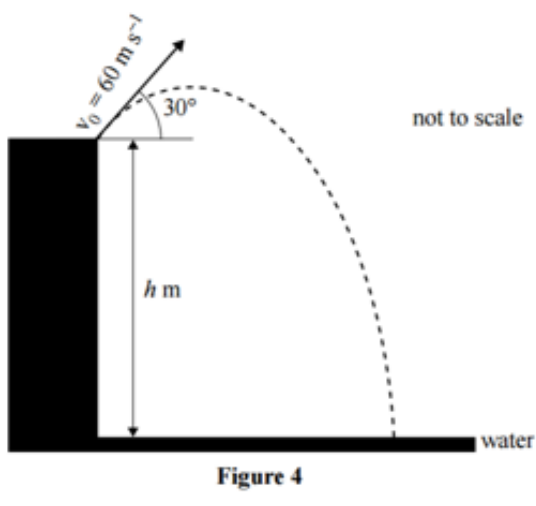
A mass of 2.0 kg is being swung by a light rod in a vertical circle of radius 1.0 m at a constant speed of 7.0 m s^{-1} , as shown in Figure 5.



Calculate the magnitude of the tension in the light rod at point S. Show the steps of your working.

Question 5 (7 marks)

Max hits a ball from the edge of a cliff. The ball has an initial speed of 60 m s^{-1} at an angle of 30° to the horizontal as shown in Figure 4. Ignore the effects of air resistance.

**Question 5.a**

4 marks

How high above the top of the cliff does the ball rise?

Question 5.b

3 marks

The ball takes 9.0 s from the time Max hits it until it lands in the water. What is the height, h , of the cliff?

Question 6 (5 marks)

A hunter is practising and sets up a target at a distance of 50 m away. This target is designed to capture the round and then move backwards on a friction free surface. This allows the hunter to calculate the speed of the round as it strike the target. Assume that all air resistance can be ignored.

Question 6.a

2 marks

If the target moves off with a speed of 8.2 m/s and has a mass of 0.40 kg, calculate the speed of the bullet just before impact if the bullet has a mass of 12.5 g

Question 6.b

3 marks

Is the collision between the bullet and the target an elastic or inelastic collision? Use calculations to justify your answer.

Question 7 (5 marks)

A rocket of rest mass 3300 kg travels at a speed of 2.7×10^8 m/s.

Question 7.a

3 marks

Calculate the relativistic kinetic energy of this rocket when travelling at this speed.

Question 7.b

2 marks

What is the difference between the Newtonian calculation of the kinetic energy of this rocket and the relativistic kinetic energy calculation?
