

1.

A satellite weighs 200 newtons on the surface of Earth. What is its weight at a distance of one Earth radius above the surface of Earth?

- (1) 50 N
- (2) 100 N
- (3) 400 N
- (4) 800 N

Answer:

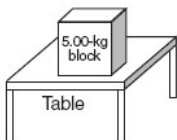
1

Scoring Guide:

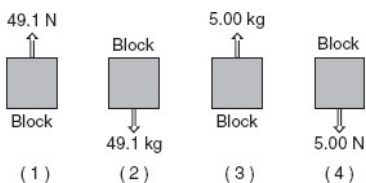
Rubric:

2.

The diagram below shows a 5.00-kilogram block at rest on a horizontal, frictionless table.



Which diagram best represents the force exerted on the block by the table?



Answer:

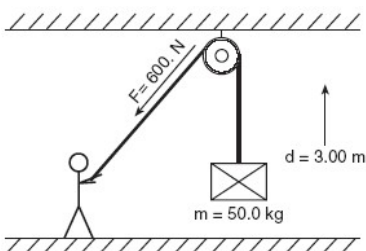
1

Scoring Guide:

Rubric:

3.

As shown in the diagram below, a student exerts an average force of 600. newtons on a rope to lift a 50.0-kilogram crate a vertical distance of 3.00 meters.



Compared to the work done by the student, the gravitational potential energy gained by the crate is

- (1) exactly the same
- (2) 330 J less
- (3) 330 J more
- (4) 150 J more

Answer:

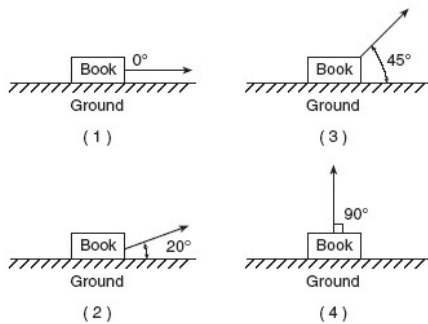
2

Scoring Guide:

Rubric:

4.

A 1.0-kilogram book resting on the ground is moved 1.0 meter at various angles relative to the horizontal. In which direction does the 1.0-meter displacement produce the greatest increase in the book's gravitational potential energy?



Answer:

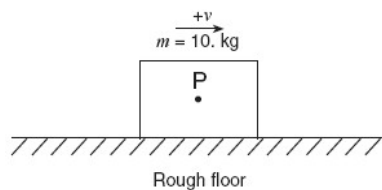
4

Scoring Guide:

Rubric:

Base your answers to the following questions on the information and diagram below.

A 10.-kilogram box, sliding to the right across a rough horizontal floor, accelerates at -2.0 meters per second² due to the force of friction.



5.

Calculate the magnitude of the net force acting on the box. [Show all work, including the equation and substitution with units.] [2]

Scoring Guide:

Allow a maximum of 2 credits.

Example of an Acceptable Response

$$a = \frac{F_{\text{net}}}{m}$$
$$F_{\text{net}} = ma$$
$$F_{\text{net}} = (10. \text{ kg})(-2.0 \text{ m/s}^2)$$

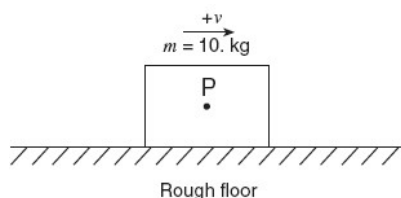
$$F_{\text{net}} = -20. \text{ N} \quad \text{or} \quad 20 \text{ N}$$

Answer:

Rubric:

6.

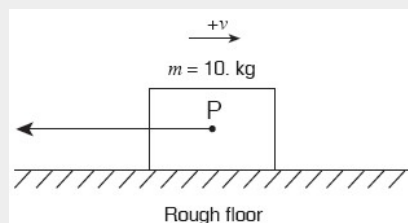
On the diagram below, draw a vector representing the net force acting on the box. Begin the vector at point P and use a scale of 1.0 centimeter = 5.0 newtons. [2]



Scoring Guide:

Allow a maximum of 2 credits. Allow 1 credit for a length of 4.0 cm (± 0.2 cm). Allow 1 credit for drawing a vector directed to the left. Allow credit even if the vector does not begin at point P.

Example of a 2-Credit Response



Answer:

Rubric:

7.

Calculate the coefficient of kinetic friction between the box and the floor. [Show all work, including the equation and substitution with units.] [2]

Scoring Guide:

Allow a maximum of 2 credits.

Example of an Acceptable Response

$$\begin{aligned} F_f &= \mu F_N \\ \mu &= \frac{F_f}{F_N} \\ \mu &= \frac{20. \text{ N}}{98.1 \text{ N}} \\ \mu &= 0.20 \end{aligned}$$

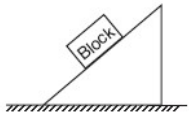
Allow credit for an answer that is consistent with the student's response to question 65.

Answer:

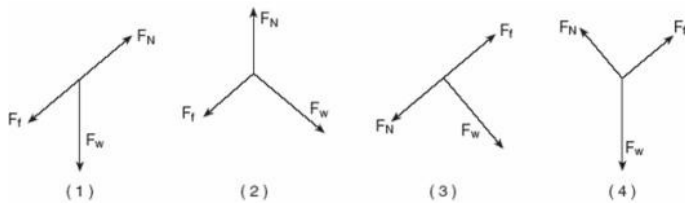
Rubric:

8.

The diagram below represents a block at rest on an incline.



Which diagram best represents the forces acting on the block? (F_f = frictional force, F_N = normal force, and F_w = weight.)



Answer:

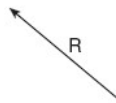
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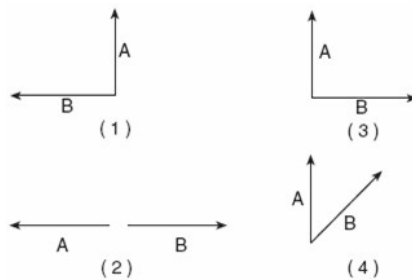
Rubric:

9.

The diagram below shows a resultant vector, R.



Which diagram best represents a pair of component vectors, A and B, that would combine to form resultant vector R?



Answer:

1

Scoring Guide:

Rubric:

10.

A person is standing on a bathroom scale in an elevator car. If the scale reads a value greater than the weight of the person at rest, the elevator car could be moving

- (1) downward at constant speed
- (2) upward at constant speed
- (3) downward at increasing speed

(4) upward at increasing speed

Answer:

4

Scoring Guide:

Rubric:

11.

The force required to start an object sliding across a uniform horizontal surface is larger than the force required to keep the object sliding at a constant velocity. The magnitudes of the required forces are different in these situations because the force of kinetic friction

- (1) is greater than the force of static friction
- (2) is less than the force of static friction
- (3) increases as the speed of the object relative to the surface increases
- (4) decreases as the speed of the object relative to the surface increases

Answer:

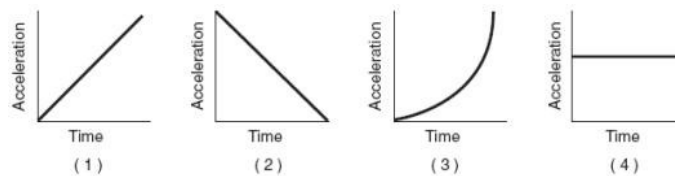
2

Scoring Guide:

Rubric:

12.

A constant unbalanced force is applied to an object for a period of time. Which graph best represents the acceleration of the object as a function of elapsed time?



Answer:

4

Scoring Guide:

Rubric:

Base your answers to the following questions on the information below.

The driver of a car made an emergency stop on a straight horizontal road. The wheels locked and the car skidded to a stop. The marks made by the rubber tires on the dry asphalt are 16 meters long, and the car's mass is 1200 kilograms.

13.

Calculate the magnitude of the frictional force the road applied to the car in stopping it. [Show all work, including the equation and substitution with units.]

Scoring Guide:

Scoring Criteria for Calculations

For each question requiring the student to *show all calculations, including the equation and substitution with units*, apply the

following scoring criteria:

- Allow 1 credit for the equation and substitution of values with units. If the equation and/or substitution with units is not shown, do not allow this credit.
- Allow 1 credit for the correct answer (number and unit). If the number is given without the unit, do not allow this credit.
- Penalize a student only once per equation for omitting units.
- Allow full credit even if the answer is not expressed with the correct number of significant figures.

Allow a maximum of 2 credits for calculating the frictional force the road applied to the car in stopping it. Refer to *Scoring Criteria for Calculations* in this scoring key.

Example of an Acceptable Response

$$\begin{aligned}F_f &= \mu F_N \\F_f &= (0.67)(12,000 \text{ N}) \\F_f &= 8,000 \text{ N} \text{ or } 8,040 \text{ N}\end{aligned}$$

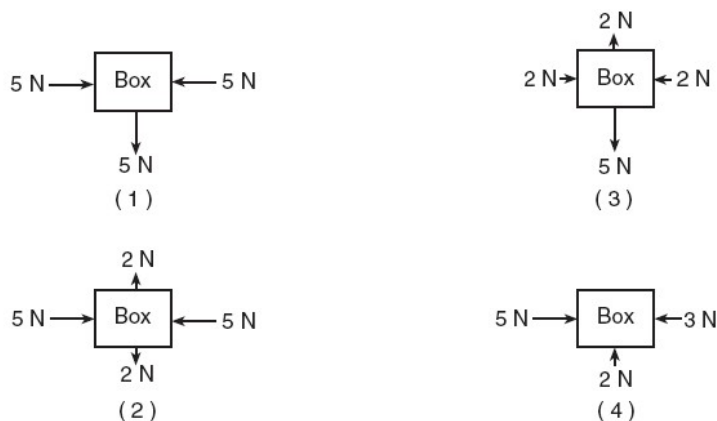
Allow credit for an answer that is consistent with the student's response to question 65.

Answer:

Rubric:

14.

Which diagram represents a box in equilibrium?



Answer:

2

Scoring Guide:

Rubric:

15.

A 1200-kilogram space vehicle travels at 4.8 meters per second along the level surface of Mars. If the magnitude of the gravitational field strength on the surface of Mars is 3.7 newtons per kilogram, the magnitude of the normal force acting on the vehicle is

- (1) 320 N
- (2) 930 N
- (3) 4400 N
- (4) 5800 N

Answer:

3

Scoring Guide:

Rubric:

16.

An 80-kilogram skier slides on waxed skis along a horizontal surface of snow at constant velocity while pushing with his poles. What is the horizontal component of the force pushing him forward?

- (1) 0.05 N
- (2) 0.4 N
- (3) 40 N
- (4) 4 N

Answer:

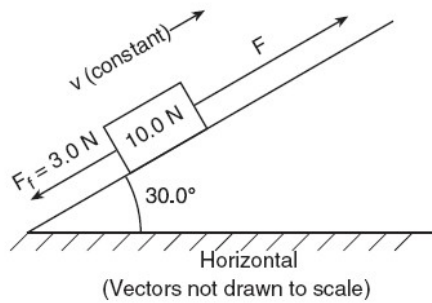
3

Scoring Guide:

Rubric:

17.

A block weighing 10.0 newtons is on a ramp inclined at 30.0° to the horizontal. A 3.0-newton force of friction, F_f , acts on the block as it is pulled up the ramp at constant velocity with force F , which is parallel to the ramp, as shown in the diagram below.



What is the magnitude of force F ?

- (1) 7.0 N
- (2) 8.0 N
- (3) 10. N
- (4) 13 N

Answer:

Scoring Guide:

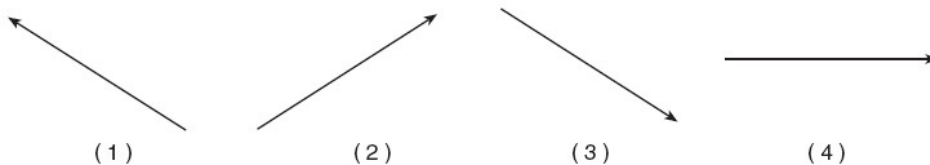
Rubric:

18.

The diagram below represents two concurrent forces.



Which vector represents the force that will produce equilibrium with these two forces?



Answer:

3

Scoring Guide:

Rubric:

19.

A force of 25 newtons east and a force of 25 newtons west act concurrently on a 5.0-kilogram cart. What is the acceleration of the cart?

- (1) 1.0 m/s^2 west
- (2) 0.20 m/s^2 east
- (3) 5.0 m/s^2 east
- (4) 0 m/s^2

Answer:

4

Scoring Guide:

Rubric:

20.

What is the acceleration due to gravity at a location where a 15.0-kilogram mass weighs 45.0 newtons?

- (1) 675 m/s^2
- (2) 9.81 m/s^2
- (3) 3.00 m/s^2
- (4) 0.333 m/s^2

Answer:

3

Scoring Guide:

Rubric: